# Refrigeration and Air-conditioning Technology

Climate change, the greenhouse effect and global warming – in the 21st Century there is scarcely any other subject that is more ubiquitous or "hotly" debated. Global environmental accords like the international Kyoto protocol or specifically the European directive on fluorinated gases are devoted to the problems associated with greenhouse relevant agents and the search for solutions on a political level. Refrigeration and air-conditioning applications amplify the effects of global warming.

In the first place they contribute directly and in a big way to the greenhouse effect through the emission of coolants containing fluorine like partially or wholly fluorinated hydrocarbons. One example of how these emissions are caused is because of leaks in refrigeration systems which allow coolants to escape into the atmosphere. Secondly, the operation of refrigeration systems also causes additional, indirect  $CO_2$  emissions due to the not inconsiderable amount of energy required for their operation. This problem is compounded by the fact that demand for refrigeration systems is constantly increasing.

Lucas-Nülle has committed itself to this subject and developed a concept to integrate easily serviceable and effective training systems devoted to this growing sector. Refrigeration and air-conditioning technology is a professional area that builds entirely the latest educational and technical know-how. It is the many years of experience that Lucas-Nülle has accumulated combining theoretical know-how with practical applications which empowers course participants to boost their skills and competence in this area.

### Modular R134a refrigeration training system



#### Modular R134a refrigeration training system

This modular refrigeration training system allows trainees to gain extensive experience of the materials used in refrigeration systems. The training focus of this module is to observe the refrigeration circuit itself. Rather than teaching professional skills as such, its objective is more to gain an understanding for the technology and the function of the components. Various applications, valves and other components of a refrigeration circuit are investigated by means of an authentic cold storage cell under a variety of conditions. The key aspects include how the quantity of refrigerant, the ambient temperature or faults with certain components affect the system. In addition, training is provided in the environmentally conscious handling of refrigerant when filling or emptying the system.

### Important!

Some of the supplies employed with this equipment set are governed by regulations on hazardous goods and therefore require special handling. We recommend procuring these supplies in the respective country of use to avoid a transport of hazardous goods. The relevant supplies are summarized in the associated section.

# RCC21 Modular R134a refrigeration training system



#### RCC21 Modular R134a refrigeration training system

This course teaches participants fundamental knowledge of refrigeration circuits. They learn about the function of components and the responses of the refrigeration circuit as a whole.

The following training contents are covered:

- Design and function of a refrigeration circuit
- · Connection of system components to a closed refrigeration circuit via hoses without a manifold
- Connection of a 4-way pressure gauge
- Rough pressure testing for leaks using nitrogen
- Identifying leaks
- · Emptying and drying
- Handling refrigerant cylinders
- Design, function, configuration and testing of safety equipment (high pressure and low pressure)
- Testing and configuring correct superheating
- · Changes to superheating and thermal expansion valves

Fully insulated mobile refrigeration chamber with evaporator, fans, CO3207-1A 165W heater

The mobile refrigeration chamber is used to study refrigeration processes in cooling, air-conditioning and ventilation systems. The sealed chamber's high degree of insulation, large volume and minimal thermal bridges achieve conditions which are nearly 100% reproducible. The obtained results can therefore be applied to almost all large-scale refrigeration facilities. The module consists of the following components:

- Mobile substructure with storage unit
- Lower storage cabinet with 3 drawers
- Cold chamber: 600mm x 600mm x 800mm (approx. 120 litres)
- Fully insulated glass door with magnetic seals and locking device
- Evaporator with two fans and defrosting tray
- Evaporator heater terminal box for power and coolant lines

#### Technical data:

- Operating voltage: 230V, 50/60Hz
- Evaporator cooling surface: 1.8m<sup>2</sup>
- Evaporator air flow: 140m<sup>3</sup> / h
- Evaporator defrosting heater: 230V, 165W
- Power connections: 3x 230V connector for non-heating apparatus
- Refrigerant connections: 2x 5/8" screw connection
- Controller ports: 2x 7/16" screw connections
- Dimensions: 600mm x 900mm x 1550mm
- Weight: 40kg



#### Compressor kit with accumulator, 230V/50Hz

The compressor is designed for small refrigeration systems and consists of the following components:

- Compressor
- Condenser
- Pressure switch KP17WB
- Collector
- 2x corner stop valves, connector at suction end 5/8" UNF connection at pressure end 7/16" UNF
- T-piece in hot gas piping with 7/16" UNF thread

#### Technical data

- Refrigerant: R134a
- Power rating: >500W at +15°C/+32°C // >170W at 15°C/+32° C
- Filling capacity: Max. 0.41
- Collector capacity: Max. 0.81
- Operating voltage: 230V/50Hz
- Nominal current: 0.2 A
- Dimensions: 200mm x 290 mm x 430mm
- Weight: 16kg

#### EVR2 solenoid valve, 230V/50Hz, 10W

Servo-controlled solenoid valve for liquid, suction or pressure/hotgas lines with fluorinated refrigerants; for all applications involving refrigeration, freezing and air-conditioning systems.

- Solenoid valve type EVR2
- AC coil 230V/50Hz
- Media temperature -40 ... 105°C
- Permissible operating pressure 35 bars
- · Switching status: Closed in the de-energized state
- Inputs and outputs: Power cable 1.5m
- Refrigerant lines: Screw connections
- Dimensions: 297 x 114 x 60mm
- Weight: 0.8 kg





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CO3207-1B

#### Filter drier with inspection window, 6mm flange

This "Eliminator filter dryer" is furnished with a flange and designed specifically for HFC refrigerant. It is connected directly with a sight glass which enables optimal monitoring of moisture content.

Technical data:

- Operating pressure: Max. 35 bars
- Temperature range: -40 ... 70°C
- Filling volume: 0.081
- Moisture indicator: Included
- Connections: 6mm flare connectors
- Dimensions: 297 x114 x 60mm
- Weight: 0.5 kg

#### Room thermostat with switchable socket for mains power CO32

The module includes a thermostat with a remote sensor and a switched socket. On attainment of the set values, a changeover contact connects or disconnects the voltage for the socket.

Technical data:

- Room thermostat KP61
- Relay: SPDT, max. 400V, 10A
- Temperature sensor with characteristic type B
- Temperature range -40 .... +65°C .....
- Capillary tube length: 2.0 m
- Sensor size: 9.5 x 70mm
- Dimensions: 297 x 114 x 60mm
- Weight: 0.8 kg



CO3207-1E



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#### Thermostatic expansion valve (TEV) TN2

The thermostatic expansion valve comprises a valve housing with an interchangeable nozzle, a measuring element, and a stainless-steel capillary tube with a probe.

Technical data:

- Temperature range: -40 ... 10°C
- Operating pressure: Max. 34.0 bars
- Nozzle: 0X
- Capillary tube length: 1.5m
- Probe: 9 x 60mm
- Connections: 5/8" UNF flare connection on suction side and 7/16" UNF flare connection on pressure side
- Dimensions: 297 x114 x 60mm
- Weight: 0.8 kg

#### Vacuum meter, 0-150 mbar, with 15-bar safety valve

The manometer indicates negative pressure in combination with the vacuum pump.

Technical data:

- Display: Analog with additional, trailing pointer
- Pressure range: 0 .. 1000 bars (+/-)
- Precision class: 1.0
- Temperature range: -25 ... 60°C
- Connection: 7/16" UNF flare connector
- Dimensions: 297 x 114 x 60mm
- Weight: 0.8 kg

### CO3207-1M





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CO3207-1G

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### Set of refrigerator hoses for connecting all components together without the use

High-grade coolant hoses with straight or cranked connections. All connections are threaded and require no tools for mounting.

Technical data:

- Operating pressure: Max. 52 bar
- Connections: Threaded, with 8-fold hose compression
- Connection: With single-sided valve core depressor
- (Schrader valve)Compilation
- Compliation 5x filling hose, 7/16", 915mm 5x filling hose, 7/16", 1830mm 1x filling hose, 36/V, 900mm 1x filling hose, 3/8", 900mm 1x filling hose, 3/8", 1800mm
- Weight: 3.0 kg



CO3207-1X

#### Media:

## Interactive Lab Assistant: Modular R134a refrigeration training system

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Multimedia experiment software with virtual instruments, instructions and documentation of results from measurements on refrigeration circuits.

Features:

- Detailed set-up animations
- Questions with feedback and evaluation logic for checking student progress
- Printable document for easy printing of instructions and solutions
- CD-ROM with Labsoft browser, course software

#### Training contents:

- Measurement of pressure using a pressure gauge
- Measurement of temperature differences
- Checking for leaks with a leakage tester
- Start-up of a refrigeration system



#### Electronic scales, 100kg, operated by 9-V battery,

Durable aluminum scale

Technical data:

- Range: 0.00kg to 100.00kg
- Resolution: 10g, 0.05lbs and 0.5oz
- Power supply: 1x 9V alkaline battery
- Functions: On/off, zero point (ZERO), units (UNIT)
- Operating temperature: -10°C to 50°C.
- Certificates: CE
- Accuracy: < 0.5% of reading
- Dimensions: 260 x 350 x 53mm

### 2-channel differential thermometer with display and connections for radio sensor

LM8575

LM8581

The differential thermometer records temperature values from 2 connected thermocouple probes, and displays these values simultaneously. Readings from an additional temperature sensor transmitted in wireless mode, i.e. via radio, can be displayed additionally on the testo 922 measuring device.

The temperature difference can be invoked directly. Current measurement data such as max./min. values can be printed out on location using Testo quick printer. During cyclic printing, measured data can be additionally output once per minute, for instance.

#### Functions:

- Display of differential temperature
- Cyclical printout of readings, e.g. once per minute
- Continuous display of max.-/min. values
- · Hold-button for retaining measured values
- Display lighting
- On-site printing with a Testo quick printer (optional)

#### Technical data:

- Operating temperature: -20 ... +50°C
- Housing material: ABS
- Storage temperature: -40 ... +70°C
- Battery type: 9V block, 6F22
- Dimensions: 182 x 64 x 40mm
- Weight: 1.0kg





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#### TopSafe protective sheath for 2-channel differential thermometer LM8576

TopSafe, an indestructible case providing protection against dirt and impact



Extremely fast-acting surface probe with a resilient thermocouple strip, also for uneven surfaces; short-term measurement range to +500°C, type K thermocouple

Technical data:

- Measuring range: -60 ... +400°C
- Sensor tube length: 115mm
- Sensor tube diameter: Ø 5mm
- Response time: 30sec
- Cable length: 1.2 m
- Accuracy class: 2
- Connection cable: Fixed, stretched

Type K pipe-contact sensor with interchangeable measuring probes for 5..65-mm pi

Technical data:

Measuring range: -60 ... +130°C

Response time: 5 sec

Cable length: 1.2 m

Accuracy class: 2

Connection cable: Fixed, stretched





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#### Manometer battery with storage case and filling hose

The 4-way manometer array is used to measure and adjust pressures in refrigeration systems. The manometer array is suitable for a variety of refrigerants. The low-pressure elements are marked blue, the high-pressure elements are marked red.

Technical data:

- Includes: 4-way manometer array, case, 3 hoses
- Mounting: Suspended
- Manometer: 2 units, oil-filled
- Class 1a
- Scale: R134a
- Hoses: 90cm
- Connections: 7/16" UNF red, black and blue, 5/8" UNF yellow
- Weight: 2.0 kg

#### Leak detection equipment for refrigerant and technical gases

This leak detector is equipped with the latest technology and represents a quick and easy way to detect leakage of coolant, featuring very high sensitivity.

- Infra-red technology
- Lifespan for infra-red sensor = 800 hours with no depreciation
- Sensitivity: 1g/year as per EN 14624
- Detects any refrigerants or NH<sub>3</sub>
- 5 Rechargeable NiMH batteries (Autonomie; 6)
- Automatic and manual zero calibration
- Sensitivity selector (Hi/Lo)
- Battery flat display
- Sensor failure warning
- Headphone socket
- With mains adapter

#### LM8582



#### LM8593



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#### Test leak for testing leak detection equipment (50ml)

- For calibration of leak detection equipment
- Test quantity 5g/per annum



LM8590

### **Operating materials**

#### Refrigerant, Suva 134a in pressurised cylinder, contents 12,51

To accomplish the actual cooling in a refrigeration system, i.e. to carry away heat, various liquids and gases are used. These are called coolants or refrigerants, which circulate around refrigeration systems transporting heat. They are alternately evaporated and liquefied (condensed). The changes in coolant state can be demonstrably shown using the refrigeration lab. In addition, the system allows for filling with coolant and for coolant to be sucked out.

#### Technical data:

Coolant type: R 134a Maximum weight of coolant in system: 12 kg Unladen weight: 7.9 kg Container: Pressurised cylinder

Test pressure: 22 bars



#### LM8594

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#### Nitrogen in pressurized cylinder, 5 l

In order to identify leaks in a refrigeration system, it is necessary to use nitrogen, which is introduced into the system and which then escapes if there are any leaks. Unlike refrigerant/coolant, leaking nitrogen is visible and causes no damage to the environment. The nitrogen should possess a purity grade of at least 4.0.

#### Technical data:

Quality: 4.0

Quantity: 5 litres in full cylinder



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#### Bottle for recycling refrigerant, unfilled, T12Y/S50

Arecycling bottle for refrigerant is needed in order to collect the old refrigerant when a new one is put in. The bottle is supplied empty. The coolant let out can either be cleaned or reconstituted into blends.

#### Technical data:

Supplied empty

Unladen weight: 7.9 kg

Maximum content when full: 9.5 kg



#### Accessories:

## Nitrogen pressure regulator RA825GN50, cylinder pressure 200 bars, excess pressure release at 50 bars

Pressure regulator for gas cylinders made of pressed brass, with pressure gauges for the cylinder contents and working pressure. The nitrogen pressure regulator has been tested by BAM.

#### Technical data:

- Tube connector: 7/16"
- Inlet pressure [bars]: 0...200
- For use with nitrogen
- Cylinder connector: W 24.3 x 1/14 (IG)
- Working pressure [bars]: 0 50
- DIN: DIN 477-1
- Weight: 1.6 kg

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Cylinder connection adapter for pressurised refrigerant cylinders and filling refrigeration systems.

#### Technical data

- Material: brass
- Cylinder connector: 1/4" internal diameter
- Tube connector: 7/16" external diameter

Special ratchet spanner refrigeration tool R6950M

- Weight: 0.12 kg
- Ratchet spanner, easily adjustable, 34 teeth, for operating shut-off valves.

Technical data:

- Standard: 1/4", 6.3 mm, DIN 3120/ISO 1174
- Ratchet heads: square socket, 6.5 (1/4") and 8 mm (5/16").
- Grip heads: square socket, 8.5, 9.5 (3/8") and 13 mm
- Design: nickel coated and chromed, highly polished finish

### High-pressure disposal equipment for refrigerant, 38.5 bars, 230V/50...60Hz

This oil-free compressor is meant for disposal of liquid and gaseous refrigerants. It is suitable for extracting all common CFC, HFC and HCFC refrigerants including R410A.

Technical data:

- Safety pressure limiter: 38.5 bar (550 psi)
- Housing: Rugged polyethylene, double-walled
- Self-cleaning function, including filter dryer
- Connection: Detachable 2.5m cable
- Power supply: 230V, 50/60 Hz
- Certified by CE & TUV
- Weight: 11kg
- Dimensions: 250 x 222 x 406mm



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LM8579

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LM8587

### Two-stage vacuum pump with oil filter

- Two-stage rotary-vane pump
- Internal oil reflux for optimum lubrication
- Large oil-filling nozzles make it simple and clean to fill with oil without using a funnel
- Easy reading of optimum oil level
- On/off switch built into housing to prevent damage and unintended switching off
- Gas-ballast valve
- Special filter to reduce amount of atomised oil around exhaust jets
- Oil change recommended after 20 hours of use

#### Technical data:

- Operating voltage: 230V/50Hz
- Electrical power: 0.16 kW, 2400 rpm
- Pump output:35 l/min
- Connector: 1/4" SAE
- Weight: 3.8 kg

#### Oil basin, 560x430x85 mm

Plastic collecting basin for various liquids. Various components of a refrigeration circuit can be put into this container in order to collect dripping condensation and keep the workplace dry and clean.

LM8598



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### SybaPro mobile IMS experiment trolley with experiment frame, 1200mm, 2 levels

ST7200-3T

These mobile, mechatronics trolleys with aluminium rails that can be lined up alongside one another are specially designed to accommodate mechatronics set-ups with production lines or pallet rotation systems. The trolleys can be cascaded and are equipped with strong table-top connectors for this purpose.

- The mobile experiment stand is delivered in kit form and needs to be assembled by the customer
- Aluminium rail with integrated grooves to accommodate a wide variety of add-on components (e.g. PC shelf, extension panels, C rails)
- 4 swivelling dual casters, including 2 with brakes
- Work top 1200 x 25 x 900mm (WxHxD)
- Board 1200 x 25 x 800mm (WxHxD), e.g. to accommodate compressors or hydraulic equipment
- Boards with compressed multi-layer chipboard conforming to DIN EN 438-1; colour light grey; with slightly textured 0.8 mm coating on both sides (Resopal) conforming to DIN 16926
- Work top frame with impact resistant protective edging made of 3mm thick coloured plastic, colour RAL 7047
- · Coating and adhesives are PVC-free
- Power strip with 5-outlet sockets and power switch, lead and earthed plug
- Height of worktop 750 mm
- Side components involving aluminium rails with integrated grooves to accommodate a wide variety of add-on components (e.g. monitor shelf, C rails, safety and signalling equipment)
- 3 natural brushed aluminium rails to accommodate DIN A4 training panels
- Inward-facing brush strips ensure protection of the training panels and noiseless connection of plugs while experiments are being performed.
- Suitable as base for a 3 HU power supply channel
- The training panel is supplied with assembly kit to connect it to a mechatronics trolley with aluminium rails (extending the aluminium rails at the rear)



#### Wall or aluminium-profile mounting cable storage for 48 cables

Accommodates about 48 safety measuring leads (4mm), suitable for mounting on walls or aluminium profiles

- Width 200 mm, 12 guide grooves for leads
- Adjustable height for mounting on aluminium profiles
- Can be mounted on the left or right
- · Can be mounted on walls
- Includes 2 screws and tenon blocks
- Acid-resistant epoxy-resin powder coating, thickness 80 μm approx., colour RAL 7047

#### Monitor holder for flat screen monitor of weight up to 15kg,VESA 75/100

Pivoting monitor holder for attachment to aluminium profiles of furniture in the SybaPro range. Allows a monitor to be placed in the optimum position so that work and experiments are less tiring.

- · Pivoting arm with two-part joint
- Quick-lock for adjustment to any height on extruded aluminium profile
- VESA fastening 7.5 x 7.5cm
- Includes VESA 75 (7.5x7.5) VESA 100 (10x10) adapter
- 2 Cable clips
- Adequate carrying capacity 15kg
- TFT monitor can be turned parallel to the table edge
- Separation can be adjusted to anywhere between 105 and 480mm

Additionally included:

Cable management set for installing cables along the profiles of the aluminium lab system furniture in the SybaPro range

The set consists of the following:

- 3 Cross cable binders for front and rear grooves of aluminium profile
- 3 Cross cable binders for side grooves of aluminium profile
- 12 Cable binders
- 4 Aluminium cover profiles for covering and enabling wires to be run along the grooves of an aluminium profile



#### ST8010-4T



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ST8003-8E