U-3ARC TRAINING WEBINAR #43

Hygiene, Safety & Environment in the Refrigeration/Air Conditioning sector

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Introduction

- Urban population growth in Africa will reach 500 million Africans in cities by 2050, threatening public health and the climate.

- Demand for air conditioning will increase by 300% by 2040, leading to critical issues of pollution and energy waste.

Key definitions of HSE

- H (Hygiene): Control of biological/chemical risks (Legionella, biocides).
- S (Safety): Prevention of technical/operational risks (leaks, fires).
- E (Environment): Reduction of impacts (GHG, waste, energy).

Global issues

1. Inefficient Air Conditioners and Refrigerants with High Global Warming Potential (GWP)

- In 2018, approximately 35% of air conditioners sold in the 10 largest African countries (Algeria, Egypt, Ghana, Kenya, etc.) were low-efficiency models (EER <3.0 W/W).
- Each year, 650,000 non-compliant units are imported, often reclaimed or assembled locally with inefficient components.
- Approximately 40% of units still use R-22 refrigerant (GWP = 1,810 times that of CO_2), while 47% of the market uses it, according to some sources.

Global issues

2. Massive GHG Leaks Due to HFCs and HCFCs

- Leaks in air conditioning systems release HCFCs/HFCs, some of which, like R-410A, have a GWP of 2088×CO_2 and an atmospheric lifetime of approximately 30 years.
- The massive use of such refrigerants contributes to approximately 2% of global warming, through their direct or indirect release.

Global issues

3. Discarded HVACR Equipment and Electronic Waste

- The import of non-compliant used appliances contributes to a waste stream of at least 250,000 tons per year, a large proportion of which are refrigerators and air conditioners.
- Informal processing of this waste releases refrigerants, heavy metals, and toxic compounds that are harmful to the air, soil, and water.

Hygiene

Definition and health risks

- Biofilms in evaporators → Listeria contamination.
- Cooling towers → Legionella (mortality rate: 10-15%).
- HVAC ducts → Allergies (20% of Europeans affected).

Critical areas

Critical zone	Associated risks
Evaporators & coils	Biofilms, molds, legionella
Air filters / HVAC ducts	Dust accumulation → bacteria/aerosols
Floors & room joints	Contamination by organic residues/moisture
Stagnant condensates	Microbial proliferation (pseudomonas, legionella)
Surfaces in contact with food	Chemical or microbial transfer (e.g. cleaning agents)
Chemical storage points	Risks of cross-contamination (corrosion, vapors)

Control methods

Hygiene

Critical zone	Recommended actions	Control methods
Evaporators / Coils	Monthly cleaning/ disinfection	Visual inspection, microbiological analysis (surface)
Air filters & HVAC ducts	Filter replacement / regular cleaning	Schedule monitoring, filter status check
Condensates & recovery tanks	Ensure drainage + disinfection	Flow test, biofilm presence control
Cold room surfaces & floors	Food detergent + disinfection	ATP sampling, HACCP checklist
Storage of chemical products	Separate storage, sealing, ventilation	Safety data sheet, validated implementation plan
Temperature and humidity	Continuous monitoring with alarm	Recorders, daily check

Health Risks for Users

Hygiene

Users (operators, storage personnel, etc.)

- Hypothermia, frostbite, and arrhythmias due to prolonged exposure to cold (< -10°C) Impaired alertness, reduced coordination, increased risk of accidents (slips, difficult handling)
- Respiratory or allergic risks due to microbiological contamination of the air (mold, Legionella in HVAC systems)

Field Service Technicians

- Direct exposure to pathogens (bacteria, mold) when handling contaminated coils or filters
- Contact with disinfectant chemicals or harmful refrigerant leaks
- Physical and thermal fatigue, affecting concentration and increasing the risk of injury

Conclusion : Prevention relies on appropriate PPE, effective ventilation, training, and regular maintenance.

Key international standards in cold & HVAC hygiene

Hygiene

- VDI 6022 (🇩🇪) : European standard for the hygiene of HVAC systems (design, inspection, cleaning).
- AIRAH (🇦🇺) : Australian guide for the assessment and cleaning of HVAC components.
- AHRI (🇺🇸) : 100+ standards on the performance, hygiene, and safety of HVACR systems.
- Hygienic By Design : Hygienic design of equipment to prevent contamination.
- EN 12830, 13485, 13486 : Measuring instruments and recorders for the cold chain.
- ISO 23953 / ex-NF EN 441 : Requirements for refrigerated display cases.
- Codex Alimentarius : Worldwide recommendations on food safety in refrigerated conditions.
- ISO 22000 : Food safety management including the cold chain.

Hygiene

African specificities

Refrigerants represent 23% of GHG emissionsWEEE in West Africa reaches 500,000 tonnes per year

Case study: Dakar Hospital

- Problem: Legionnaires' disease outbreak linked to the cooling tower.
- Solution: Shock cleaning + IoT monitoring sensors.
- Result: 0 cases in 18 months

Safety

Definition and issues

- Electrical, thermal, chemical (refrigerants), and mechanical (rotation, pressure) risks.
- Falls from height during installation or maintenance.
- Inhalation of toxic fluids (e.g., ammonia, HFCs).
- Allergen or infection risks (dirty pipes, bacteria such as Legionella).

Chemical risks

Safety

Refrigerants

- HFCs, HCFCs, HFOs, hydrocarbons (R290, R600a), ammonia (R717)
- Toxic inhalation, asphyxiation, risk of explosion or fire

Lubricating oils

- May contain irritating or harmful additives
- Risks in case of prolonged contact or projection

Cleaning or disinfecting products

- Aerosols, solvents, acids or alkalis
- Inhalation, chemical burns, allergic reactions

Corrosion and degradation of materials

- Formation of toxic secondary compounds (oxides, acids)

Accidental leaks or releases

- Risks of acute or chronic exposure for workers
- Contamination of indoor air and the environment

Technical risks

Safety

Technical Risk	Common Causes	Possible Consequences
Refrigerant leak	Poor crimping, corrosion, vibration, shock	Performance loss, pollution, freezing, fire
Overheating / Overpressure	Ventilation failure, blockage, faulty sensor	Compressor damage, explosion
Electrical insulation failure	Humidity, insulation wear, poor grounding	Short circuit, electric shock, fire
Poor sizing / installation	Calculation errors, non-compliance with standards (DTU), no thermal study	Malfunction, overconsumption, discomfort, non-compliance
Ventilation / air circulation failure	Obstruction, poor grille positioning, flow imbalance	Poor air quality, condensation, mold, discomfort
Unsafe maintenance and lifting	Lack of procedures, inappropriate equipment, lack of training	Falls, serious injuries, equipment damage

Safety

Real Accident 1: Ammonia Leak (Abidjan, 2022)

- Context :
  - Fish factory, corroded valve.
- Sequence :
  - Undetected leak → 3 technicians exposed without PPE.
  - Death from pulmonary edema (1), chemical burns (2).
- Causes :
  - Lack of detectorsPreventive maintenance not performed.

Real Accident 2: Fire (Johannesburg, 2021)

Safety

- Context: Shopping center, overloaded HVAC compressor.
- Sequence:

Short circuit → Fire in the ducts.

Evacuation of 300 people, 2 seriously injured.

- Causes: Faulty wiring, lack of suitable fire extinguishers.

Safety

Real Accident 3: Asphyxiation (Accra, 2023)

- Context: Cold storage (-30°C), CO_2 leak.
- Sequence:

Technician intervened alone → Respiratory distress → Death.

- Causes: Isolated work procedure not followed, gas detector missing.

Safety

Preventive measures

- **Technical and human prevention:**
  - Suitable PPE: gloves, goggles, masks, safety shoes
  - Detection: gas, leaks, pressure, temperatureT
  - raining & certification: electricity, fluid handling
  - Regular maintenance: ducts, filters, refrigeration units
  - Safe handling: fluid recovery, ventilation, storage

- **Regulatory and environmental prevention:**
  - Compliance with standards: EN 378, ISO 5149, VDI 6022
  - Waste management: used fluids, filters, oils
  - Leakage checks, maintenance log
  - Replacement of high-GWP fluids (HFC → R32, R290)

Safety

International standards

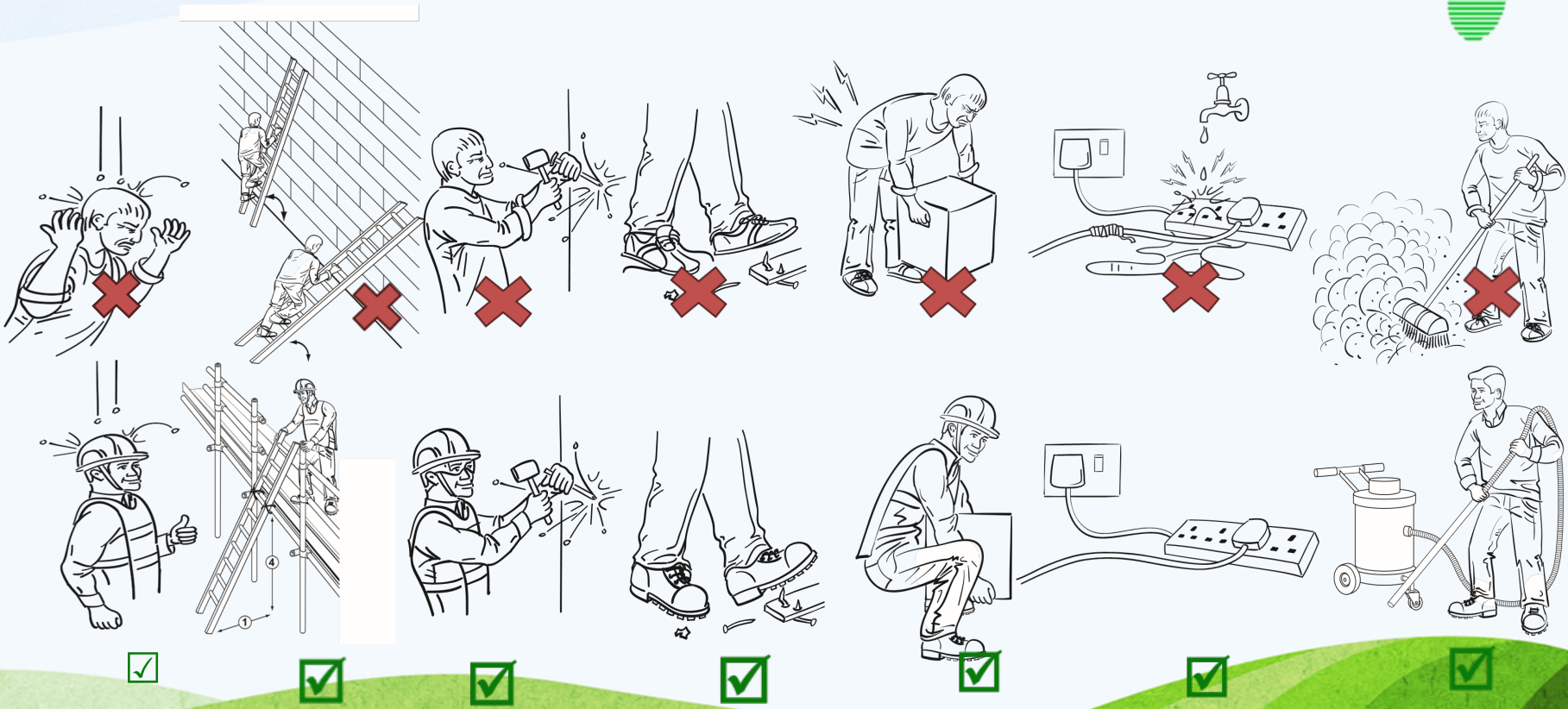
- ISO 5149 (refrigeration systems safety), NFPA 70 (electricity).

African regulations

Country	Status of HVACR safety regulations/standardization
Tunisia	- Strict enforcement of the EU F-gas regulation. Mandatory training for technicians - .Periodic inspections of pressure equipment and electrical installations. - Regular inspections and penalties. - Difficulties with enforcement in rural areas.
Ivory Coast	- Gradual adoption of IEC and AFNOR standards. - Enhanced electrical safety. - Periodic equipment inspections. - Training focused on chemical and mechanical risks. - National inventory of planned installations - .Limited enforcement and sanctions in the informal sector.
South Africa	- Robust and comprehensive SANS standards. - Mandatory technician certification. - Regular facility inspections. - Ongoing awareness campaigns. - Leading model in Africa for HVACR safety.

Safety

Work safely



Definition and impacts

- Refrigerants: R404A (GWP* = 3,922), R32 (GWP = 675).
- Energy consumption: 40% in HVAC in the tertiary sector (Africa).

GWP = Global Warming Potential

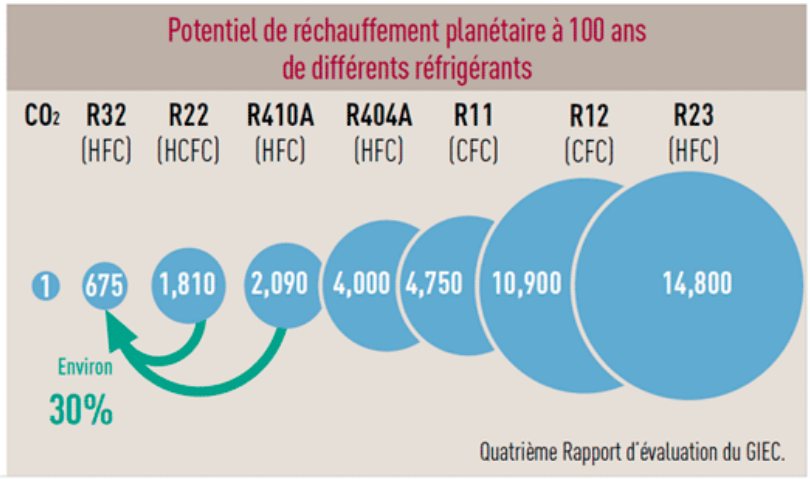
Environment

Environment

Green technologies

- Natural fluids: NH_3 (GWP=0), CO_2 (GWP=1), hydrocarbons.
- Heat recovery: Efficiency +35%.

Les fluides frigorigènes ont un indicateur pour mesurer leur impact sur l'effet de serre : le PRG (Pouvoir de Réchauffement Global). Plus le PRG est faible, plus l'impact sur l'environnement est limité.



Environment

Case study: Solar cold chain (Senegal)

- Solution: Solar CO_2-powered cold rooms for small producers.
- Results:
  - GHG reduction: 30%.
  - Food losses: -25%.

Environment

International standards

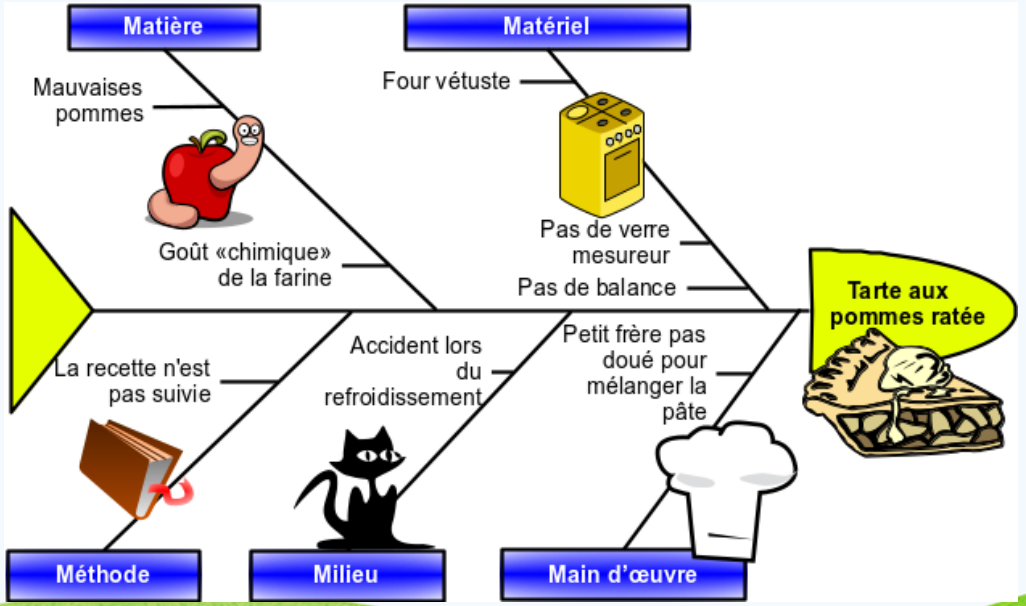
Montreal Protocol, Kigali Amendment (HFC reduction).

African initiatives

Country	HVAC Standards and Regulations	Main objectives
Rwanda	MEPS, labeling, technician certification	Reduce HFC imports, train technicians
Tunisia	Minimum Energy Performance Standards (MEPS) & labeling requirements	Energy saving, selection of high-performance products
South Africa	SANS 941, SANS 10147, HCFC-Kigali plan	Safety, maintenance, reduction of harmful substances
Sahel	Adoption Kigali, HFC-free pilot projects	Regional harmonization, technical strengthening

Interdépendance des axes

- Example : NH_3 leak →
  - S: Danger to life,
  - H: Air contamination,
  - E: Soil/water pollution.



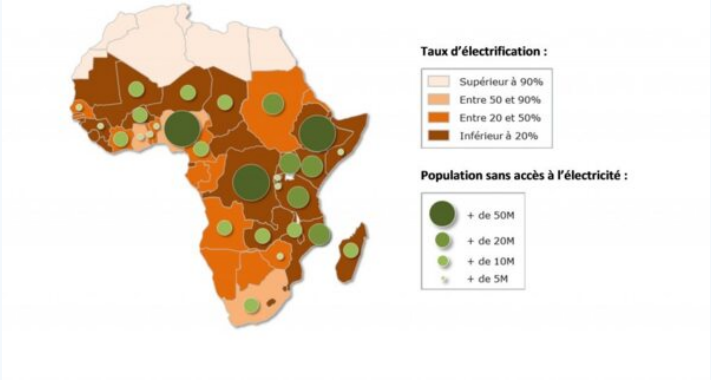
Integrated management tools

- Systems : ISO 14001 (environment), ISO 45001 (safety).
- Software : Electronic records management, combined audits.

HSE integration

African Perspective

- Climate :
- Heat stress → HVAC demand +60% by 2050 (World Bank).
- Infrastructures :
  - 60% of rural areas without electricity.
  - Failing cold chain → Food losses > 40% (FAO).



Accidents in Africa

- Trends:
  - 70% of accidents are linked to obsolete imported equipment.
  - Chronic underreporting (lack of reporting systems).
- Key factors:
- Lack of training, informality, corruption.

HSE integration

Case Study: ColdHubs Project (Nigeria)

- Solution: Solar-powered cold rooms in containers (propane).
- HSE Results:
  - H: Reduction in foodborne illnesses (-35%),
  - S: 0 accidents in 3 years (continuing training),
  - E: 0 CO_2 emissions.

HSE integration

Action levers

- Technical: Develop solar cooling and natural fluids.
- Regulatory: Harmonize standards through ECOWAS or the AU.
- Training: Create regional certification centers.

Strategic recommendations

- Priority 1 : Integrate HSE into public tenders.
- Priority 2 : Subsidies for natural fluids.
- Priority 3 : North-South partnerships for technology transfer.

Summary conclusion

- In Africa, HSE in refrigeration/HVAC systems is a triple opportunity:

Health: Reduce air- and food-related illnesses

Economic: Avoid losses (accidents, energy, food)

Ecological: Move toward low-carbon technologies

Recommendations

General HSE recommendations – All profiles

- Hygiene:
  - Keep surfaces and tools clean
  - Avoid dust and moisture
  - Wash hands regularly
  - Check filters and seals
- Safety:
  - Comply with instructions
  - Wear appropriate
  - PPEFirst aid training
  - Identify risks (fluid, electrical)
- Environment:
  - Zero fluid discharge
  - Waste sorting
  - Energy-saving practices

Recommendations

For installers – Good HSE practices

- Before installation:
  - Analyze the site
  - Prepare tools
  - Store properly
- During:
  - Ergonomic postures
  - Protect the site
  - Avoid temporary wiring
- After:
  - Check for leaks
  - Clean the area
  - Compliant labeling

Recommendations

For maintenance technicians

- Hygiene :
  - Clean filters and heat exchangers
  - Remove mold
  - Disinfect tools
- Safety:
  - Pressure/temperature control
  - Wear detection
  - No opening under pressure
  - Test safety devices
- Environment:
  - Recover fluids
  - Secure storage
  - Avoid waste

Recommendations

For End Users – Essential Tips

- Hygiene :
  - Regular cleaning of the grilles
  - Do not obstruct the units
  - Ventilate the premises
- Safety:
  - Do not handle in case of an anomaly
  - Turn off the power before intervention
  - Call a certified professional
- Environment:
  - Low GWP equipment
  - Compliance with maintenance
  - Optimized temperatures

HSE culture and collective responsibility

Recommendations

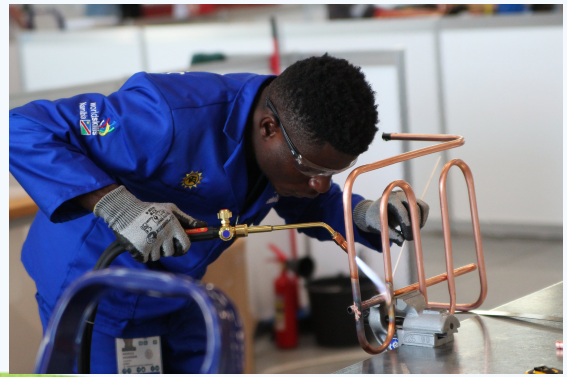
- ❑ Continuously train in best practices
- ❑ Display visible instructions
- ❑ Report incidents
- ❑ Regularly audit installations

Conclusion

A good HVACR professional = safety, performance, ecology

Final message

" Investing in HSE means building a resilient, competitive and humane refrigeration industry."



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Merci

Thanks

Gracias

Obrigado

Do you have any questions?

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