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Ahmad Mullah Saleh

How to train local staff in Africa to install Vaccine Storage Rooms

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Bachelor’s Thesis | Abstract

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How to train local staff in Africa to install Vaccine Storage Rooms

This study examines the design and execution of a training initiative focused on building technical and managerial capacity among local personnel in several African nations. The goal was to prepare them to install and maintain walk-in cold rooms used for vaccine storage.

These cold rooms, supplied through collaborations with UNICEF and national health ministries, play a critical role in keeping vaccines stable under regulated temperatures. The research addresses both the theoretical principles of refrigeration such as the function of compressors, evaporators, and condensers and the hands on process of setting up monoblock and split system cold rooms.

Installation steps, performance verification methods, and standard maintenance routines are outlined to enhance system durability and dependability. A significant portion of the training was dedicated to practical exercises for local technicians, fostering self-sufficiency in operations and minimizing frequent technical failures. The initiative illustrates how structured capacity building can contribute to long-term healthcare infrastructure resilience.

Keywords:

Refrigeration, compressor, evaporator, condenser, Monoblock, Split.

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How to train local staff in Africa to install Vaccine Storage Rooms.

Tässä tutkimuksessa tarkastellaan koulutushankkeen suunnittelua ja toteutusta, jonka tavoitteena oli vahvistaa teknisiä ja hallinnollisia valmiuksia paikallisen henkilöstön keskuudessa useissa Afrikan maissa. Tavoitteena oli kouluttaa heitä asentamaan ja ylläpitämään rokotteiden säilytykseen tarkoitettuja kylmävarastoja (walk-in cold rooms).

Nämä kylmähuoneet, jotka toimitettiin yhteistyössä UNICEFin ja kansallisten terveysministeriöiden kanssa, ovat keskeisessä asemassa rokotteiden säilyttämisessä säädellyissä lämpötiloissa. Tutkimus käsittelee sekä kylmätekniikan teoreettisia perusteita – kuten kompressoreiden, höyrystimien ja lauhduttimien toimintaa – että monoblock- ja split-järjestelmien käytännön asennusprosessia.

Asennusvaiheet, suorituskyvyn varmistusmenetelmät ja vakiintuneet huoltokäytännöt on esitetty järjestelmien kestävyyden ja luotettavuuden parantamiseksi. Merkittävä osa koulutuksesta keskittyi käytännön harjoituksiin, joiden avulla paikalliset teknikot pystyvät itsenäisesti käyttämään ja ylläpitämään järjestelmiä sekä vähentämään teknisiä häiriöitä. Hanke osoittaa, kuinka rakenteellinen osaamisen kehittäminen voi edistää terveydenhuollon infrastruktuurin pitkäaikaista kestävyyttä.

Asiasanat:

Refrigeration, compressor, evaporator, condenser, Monoblock, Split.

Content

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1 Introduction

The job at Porkka was in the installation and operation department, in addition to training the operators of the refrigerated vaccination rooms and freezers on the use of the rooms and how to operate and maintain them.

During the period of work, the project that was completed 13 in several African countries, and all of these projects were successfully completed and delivered to UNICEF and the Ministry of Health in the country in which the project took place.

Which the room consists of main components such as a metal panel, a metal ceiling and two AC.

When the project was received, the work plan was prepared with UNICEF in the country in which the project will take place, where a set of tasks that must be ready to implement the project are emphasized:

The place where the cooling or freezer room is installed must be completely pre-pared and must be within certain measurements that vary according to the size of the room. The floor that will hold the room must be dry, free of holes or ridges, and clean as well. The main entrance to the room must be It is well spacious in order to ensure that the parts of the cold room enter smoothly without any dam-age or scratches to the parts of the cold room. Also, ventilation must be good in the room in order to ensure that the cold room works more effectively, especially when installing refrigerated rooms or freezers with a regular refrigeration unit. The room must be equipped with the necessary electrical wiring in order to connect the voltage regulation unit inside the room, which is usually located near the refrigerator or freezer room. Upon confirmation by UNICEF and the Ministry of Health of the readiness of the place, the arrangement for travel to the destination country within a period ranging from three days to a week to begin implementing the project until the project is fully delivered and then move to the next destina-tion in order to continue working on a new project. The company has implemented many projects through local work teams in Africa, but technical problems always occur in the installation and operation of cold rooms. Therefore, this study was implemented in order to reduce errors in implementing future projects and help the work team in completing projects in the correct way to obtain excellent results in all future projects. With out any challenges or difficulties.

2 Comprehensive Theoretical Overview of Compressors, Evaporators, and Condensers in Refrigeration and Air Conditioning Systems

Refrigeration and air exertion systems are integral to ultramodern life, furnishing comfort and conserving perishable goods. crucial to their functionality are three critical factors compressors, evaporators, and condensers. This comprehensive theoretical overview aims to interpret the abecedarian principles governing these factors, their relations, and their places in the refrigeration cycle (Liang, 2017, 260).

2.1 Compressors

A compressor in a refrigeration system is a mechanical device that increases the pressure of a refrigerant vapor by reducing its volume. This process elevates the refrigerant's temperature and pressure, enabling it to release absorbed heat in the condenser. Compressors are essential for maintaining the refrigeration cycle, icing effective heat transfer and system performance (Falah Alobaid, 2017, 100).

Types of Compressors

2.1.1 Reciprocating compressors

Reciprocating compressors are positive-displacement devices that employ pistons powered by a crankshaft to compress gases. They are fit for high-pressure, low-flow uses and are regularly used in industries like gas processing and refrigeration. These compressors can be single or multi-stage, and their design allows versatility in managing different gases (Saeid Mokhatab, 2012, 336).

2.1.2 Rotary Screw Compressors

Rotary screw compressors use two meshing helical rotors to compress gas. They offer a continuous stream of compressed air, making them perfect for industrial uses needing big amounts of air. These compressors are known for their dependability,minimal maintenance, and capacity to run at high velocities (Perez, 2019, 99).

2.1.3 Centrifugal Compressors

Centrifugal compressors are dynamic apparatuses that boost gas pressure by imparting kinetic energy via a rotating impeller. They are ideally suited for applications needing high flow rates and are often found in large-scale industrial procedures, including chemical plants and gas turbines (Perez, 2019, 53).

2.1.4 Scroll Compressors

Scroll compressors comprise two interleaved spiral scrolls, one static and another orbiting, to compress gas. They are small, silent, and effective, making them common in residential and light commercial air conditioning and refrigeration setups (G. F. Hundy, 2008, 59).

2.1.5 Diaphragm Compressors

Diaphragm compressors employ a flexible membrane to compress gas, ensuring that the gas doesn't come into contact with moving components. This design is optimal for managing poisonous, volatile, or high-purity gases, as it forestalls contamination and leakage (Xueying Li, 2019, 24302).

2.1.6 Axial Compressors

Axial compressors compress gas by speeding it up through a sequence of rotating and stationary blades placed along the axis of the shaft. They can handle large volumes of gas and are often employed in jet engines and fast-paced industrial applications (Brown, 2005, 151).

2.2 Evaporators

An evaporator is a device used to remove water or other liquids from solutions by evaporation, concentrating the remaining substance.

This device is very important in many fields, such as the food industry, chemical plants, refrigeration systems, and the pharmaceutical industry. a liquid is heated until it turns into vapor, leaving the solution concentrated. The basic idea is to transfer heat to the liquid to evaporate it and separate it from the dissolved solids (Celeste M. Todaro, 2014, 344).

Types of evaporators

2.2.1 Falling Film Evaporators:

These devices force the liquid to flow downward as a thin layer on the walls of vertical tubes. They are particularly suitable for heat-sensitive materials because the liquid's residence time is short and the temperature difference is low. This makes them an excellent choice for concentrating solutions such as fruit juices and pharmaceutical products (Chuang-Yao Zhao, 2019, 7).

2.2.2 Rising Film Evaporators:

The liquid flows upward through vertical tubes and, when heated, begins to evaporate, forming a thin film on the walls.

This evaporation method has many practical advantages. Heat is transferred more efficiently due to the continuous movement of the liquid. The unique design helps improve the efficiency of the entire process. it is used in a variety of fields. The food industry relies on them to concentrate juices and solutions. Chemical plants also benefit from them in various manufacturing processes (George Saravacos, 2016, 337).

2.2.3 Multiple-Effect Evaporators:

Multi-stage vaporizers work very intelligently. The basic idea is that they use the steam generated from the first stage to heat the next stage. This system significantly reduces energy consumption (Rubens E.N. Castro, 2022).

2.3 Condensers

A condenser is basically a device that cools down vapor until it turns into liquid. You'll find these things in all sorts of places, from big power plants to your home AC unit. It works by moving heat from the vapor to something cooler like water or air.

They're pretty important because without them, a lot of systems just wouldn't work right. The whole phase change thing might sound complicated, but it's just about turning gas back to liquid by taking the heat out. Different industries use them in different ways, but the basic idea stays the same (LEED, 2012, 395).

3 Fundamentals and Operation of Cold rooms and Freezers

Cold rooms and freezers are pretty important when it comes to keeping Medicines, vaccines and food. They work by keeping things at low temperatures, which helps stop bacteria from growing too fast. It's all about controlling the environment so stuff doesn't go bad quickly.

There's some science behind how they function, with different parts working together to keep the temperature just right. They're designed to use energy efficiently, the technical stuff matters more for the people who build and maintain these systems.

3.1 Fundamentals of Cold Rooms and Freezers

Thermodynamic Principles

The operation of cold rooms and freezers is based on the refrigeration cycle, which involves the absorption and rejection of heat through a closed system comprising a compressor, condenser, expansion valve, and evaporator. In this cycle, a refrigerant absorbs heat from the interior space (evaporator), is compressed to a high-pressure gas (compressor), releases heat to the surroundings (condenser), and then expands to a low-pressure liquid (expansion valve) to repeat the cycle (G. F. Hundy, 2008, 1).

Refrigerants

The choice of refrigerants plays a critical role in heat transfer within refrigeration systems. Ammonia, carbon dioxide, and hydrocarbons such as propane are among the commonly used options.

Several factors come into play when selecting refrigerants. Thermodynamic efficiency matters, but so do safety concerns and environmental consequences. Lately, there’s been a shift toward natural refrigerants, partly because they tend to have a reduced impact on global warming.

The discussion around refrigerants isn’t just technical—it’s also shaped by regulatory pressures and sustainability goals. Some older refrigerants are being phased out, while alternatives are still being evaluated for long-term viability. The balance between performance and environmental responsibility remains a challenge (G. F. Hundy, 2008, 30).

Types of Freezers

Different freezers work in different ways to keep things frozen. Some blow really cold air at high speed to freeze stuff quickly - those are called air blast freezers. Then there are contact freezers where things get cold by touching freezing surfaces directly.

The super fast ones use cold liquids like nitrogen - those are cryogenic freezers. And some freezers mix both methods, using cold liquids plus mechanical cooling, which makes them cryomechanical freezers.

They all do the same basic job but go about it differently. Some are faster, some are more efficient - depends what it needs frozen and how quick they need it done (G. F. Hundy, 2008, 177).

3.2 Operational Aspects

Keeping the right temperature and humidity is key when storing things like frozen meat. If it gets too warm or dry, the quality drops fast. Most places keep frozen meat between -18 and -25 degrees, with the air feeling almost damp to stop it from drying out.

Air needs to move around properly inside storage areas. If it doesn’t, some spots get colder than others, which isn’t good. That’s why they set up fans and cooling units in certain spots to keep things even.

The walls and doors matter too. Good insulation keeps the cold in and the heat out, which saves energy. Doors should shut tight, some even have special flaps or close super fast so the cold doesn’t escape every time someone walks in.

4 Monoblock and Split systems

4.1 Monoblock Refrigeration Systems

Monoblock refrigeration systems are compact, self-contained units that integrate all essential components namely the compressor, condenser, evaporator, and expansion device into a single assembly. Typically, these units are mounted di-rectly onto the wall or ceiling of a cold storage room, making them especially suitable for small to medium-sized facilities where space is limited.

A major advantage of monoblock systems lies in their straightforward installation process. Since all components are pre-assembled within the unit, there is no need for connecting refrigerant lines between separate parts, which significantly reduces installation time and complexity.

Their space-saving design is another benefit, as the entire refrigeration mechanism is enclosed within a single unit. This eliminates the need for allocating addi-tional space to house individual components, an important consideration in com-pact storage environments.

Monoblock systems also tend to have fewer refrigerant leakage issues. The sealed construction minimizes potential leak points, thereby enhancing operational reliability and reducing environmental impact.

Maintenance is generally more accessible and efficient with these units. The centralized configuration allows for quicker inspections and repairs, as all mechanical parts are housed in one easily reachable location.

However, there are notable limitations. Because the condenser is housed within the same unit, effective ventilation is required to dissipate heat. This can be problematic in confined or poorly ventilated spaces. Additionally, noise levels may be higher, as all mechanical operations occur within the indoor environment, which may not be ideal for noise-sensitive settings.

Finally, monoblock systems are typically best suited for small-scale applications. While they offer excellent performance for limited-volume cold storage, they may not be adequate for facilities requiring large-scale refrigeration capacities (B. Citarella, 2022, 3).

4.2 Split Refrigeration Systems

Split refrigeration systems are characterized by the separation of core components into two distinct units: an indoor evaporator unit and an outdoor unit that houses the condenser and compressor. These two units are connected via refrigerant lines, which allow for flexible installation and contribute to improved thermal efficiency. Due to their ability to support higher cooling capacities, split systems are commonly employed in large commercial and industrial cold storage applications.

One significant advantage of split systems is their superior heat dissipation. Positioning the condenser outdoors facilitates more effective heat rejection compared to configurations where all components are housed indoors. This contributes to more efficient system operation and energy savings.

Additionally, split systems offer a quieter indoor environment. As the compressor, which is typically the primary source of operational noise, is located outside the building, the indoor unit generates minimal sound an important benefit for areas where staff are present or where noise-sensitive goods are stored.

Scalability is another key benefit. Split systems can be configured to accommodate increasing cooling demands, making them suitable for extensive facilities such as large-scale cold storage warehouses that require substantial refrigeration capacity.

However, these systems are not without drawbacks. Installation tends to be complex and requires skilled professionals to handle refrigerant piping, electrical connections, and system calibration. The process is more time-intensive com-pared to self-contained units.

From a financial perspective, split systems typically involve higher initial costs. This includes not only the expense of the equipment but also the additional labor and materials required for installation.

Maintenance can also pose challenges. Given that system components are distributed across both indoor and outdoor locations, even routine service tasks may require more time and effort compared to single unit systems. Accessing and troubleshooting components in separate locations can complicate otherwise straightforward maintenance operations (F. Botticella, 2018, 133).

5 INSTALLATION STEPS

Cold rooms are specialized surroundings designed to maintain controlled tempera-tures, making them necessary in diligence similar as food storehouse, medicinals, and exploration. The installation of cold rooms involves intricate processes to guarantee optimal performance, energy effectiveness, and trustability. This report aims to present a comprehensive companion for the installation of cold rooms, pressing crucial way and considerations.

5.1 primary Planning

The success of any cold room installation design begins with scrupulous planning. The following way are pivotal in the primary planning phase

point Selection

- Choose a position with ample space, proper ventilation, and availability for conserva-tion and implicit expansions.

Temperature Conditions

- Determine the specific temperature range needed for the cold room grounded on the nature of stored particulars or intended use.

sequestration Accoutrements

-Select sequestration accoutrements with applicable thermal parcels, considering factors similar as consistence and conductivity.

Power Supply

- insure a stable and devoted power force with the necessary electrical specifications.

- Plan for provisory power results to alleviate the threat of power failures.

5.2 Installing the entire room

Foundation Preparation

- position the bottom to insure indeed weight distribution.

- Install a vapor hedge to help humidity infiltration.

Frame Assembly

- Assemble the cold room frame according to the manufacturer's instructions.

- insure proper alignment and securely anchor the frame to the bottom.

sequestration Installation

- Apply sequestration material to the walls, bottom, and ceiling.

- Seal joints and seams strictly to help thermal leaks.

Panel Installation

- Mount isolated panels onto the frame.
- insure panels are securely installed, minimizing the possibility of air gaps.

Door Installation

- Install the cold room door with proper seals to maintain sequestration.
- insure the door closes securely, and consider the addition of a door heater to help ice buildup.

Refrigeration System Setup

- Install the refrigeration unit according to the manufacturer's specifications.
- Connect the evaporator, condenser, and control systems.
- Charge the refrigeration system with the applicable refrigerant.

Temperature Control System

- Install a temperature control system with detectors and an interface.
- Calibrate the system to achieve the asked temperature range.

Final Checks

- Conduct thorough examinations for gaps, leaks, or sequestration issues.

- corroborate the functionality of the refrigeration and control systems.

5.3 Safety Considerations

Safety is of utmost significance during the installation process to help accidents or injuries. Proper preventives include:

particular Defensive outfit: including gloves, safety spectacles, and defensive apparel.

Electrical Safety:

- Cleave to electrical safety guidelines during the installation of electrical factors.

- apply proper grounding and sequestration ways.

Refrigerant Handling:

- Follow recommended procedures for handling refrigerants to minimize health pitfalls.

- Educate labor force on the safe use and disposal of refrigerants (Group, 2021).

6 Tests

For each room, there are four tests:

6.1 Cooling time test

Temporary temperature data recorders installed when the room temperature is equal to the temperature of the place outside, and then the door closed and turned on the cooling. The next step is to turn on the temperature recorders and calculate the time from starting the cooling operation until the room temperature reaches +4 for the refrigerated room and -15 for the freezer.

6.2 Running Test

Operational testing and temperature mapping:

Room temperatures stabilized after the cooling time test. the room was empty and the door closed.

Throughout the testing period. the test conducted for 24 hours and record the total operating hours of the compressor during the test period.

After the temperature mapping test, the indoor and outdoor temperatures recorded and the evaporator and condenser temperatures.

From the analysis of the logger data, the maximum temperature determined differences in the room and the location of any cold or warm areas.

6.3 Tests of control and monitoring equipment

Testing the data logger, a full set of reports generated and verified that they are satisfactory. High temperature alarm test and low temperature alarm test.

defrosting tested and make sure that the evaporator fan does not work during the defrosting period, as the defrosting process performed for all refrigeration units. After that, the alarm tested the unit through two different methods. The first is by reducing the temperature and waiting for one minute until the alarm light flashes, emitting a loud beep, and then leaving the room door open to ensure that the alarm unit is working properly.

6.4 Temperature Holdover test

In the event of a power outage, the cold room temperature must remain above +2°C at the specified level and minimum ambient operating temperature, or below +10°C at the specified maximum. Test run time of at least 8 hours.

After completing the installation and tests

The installation period with tests is usually between two to three days, and then it is operated and the necessary reports are prepared and delivered to UNICEF or the Ministry of Health concerned with the project in the country in which the project took place. Then the Ministry sends their employees responsible for operating the room in order to train them on how to use it properly, maintain it periodically, and keep it working well, and how to deal with certain cases, such as the mechanism of operation of the alarm unit and what to do, or in other cases, if the room is not working. In the required manner and how to deal with these cases, in addition to stabilizing the temperatures according to the vaccine to be stored in the room.

Upon completion of installation and operation, A report prepared on the completion of the installation of the cooling and freezing rooms through a checklist. This list includes several main sections related to the condition of the building and the cold room enclosures, as well as the cooling and temperature monitoring equipment, in addition to all tests, whether they have been successful tests or not. If the room does not pass the required test, the test repeated after verifying the reason that prevented it from passing the test from beginning.

7 Training of local staff on Maintenance

conservation and form

Regular conservation is pivotal to insure the unit functions efficiently, has a prolonged lifetime, and adheres to safety norms. Only good and trained technicians should perform conservation tasks.

Ordinary conservation

To keep the outfit in peak condition

Daily Check and clean the evaporator to help ice buildup.

Yearly Clean the condenser grounded on environmental conditions.

Always turn off the outfit before cleaning. Use an air spurt from the out-side to the inside, or a long- bristle encounter if air cleaning isn't possible.

Periodic and preventative conservation

- Every four months, carry out the following checks
- check and clean electrical connections and contactors. Replace any worn factors if demanded.
- insure that wiring and outstations are forcefully secured.
- Conduct a visual examination of the refrigeration circuit for oil painting traces or implicit leaks. Check the oil painting position.
- Test for refrigerant gas leaks.
- corroborate that all safety, control, and alarm bias are working rightly.

Every five times, perform:

- A full examination of the refrigeration system, including safety faucets and pressure outfit.

- An assessment of the system’s energy effectiveness.

Servicing by good Staff

Some operations bear technical specialized moxie and must only be per-formed by authorized labor force. druggies must not essay the following:

- Replacing electrical factors or tampering with the electrical sys-tem.

- Repairing mechanical corridor or altering the refrigeration system.

- conforming the control panel or operating switches (ON, STOP, EMERGENCY).

- Modifying defensive and safety bias.

- Cleaning the condenser (Group, 2021, 139).

8 Problems

Specialized Problems

Blocked Compressor

A compressor blockage occurs when the motor’s coil temperature exceeds the maximum limit. Implicit causes include

- shy ventilation in the unit’s position.
- Electrical force irregularities.
- nonoperating condenser addict.
- The erected- in defensive device resets itself automatically formerly normal conditions are restored.

Ice conformation in the Evaporator

- Ice buildup can obstruct tailwind and may affect from
- Doors being left open or constantly opened.
- nonoperating evaporator addict.
- imperfect solenoid stopcock or defrost system.
- Abuse of the unit, similar as for indurating purposes.

good labor force may address this by

- adding the defrost thermostat’s temperature.
- adding the number of defrost cycles.

Control Unit Display Issues

If the display does n't turn on

- Check that the unit is connected and the power string is secure.
- check the fuses on the electrical panel.

If the display works but the unit doesn't start

corroborate that the door micro switch connection is performing rightly.

Poor Unit Performance

When performance issues persist without identifiable faults

- insure cold room doors are sealing duly to help air leakage.
- Confirm applicable operation, avoiding storehouse of defrosted particulars in low- temperature settings.
- Check for liquid accumulation in the evaporator.

For bettered effectiveness, position the unit down from doors that are constantly opened (Group, 2021, 140).

8.1 FAILURE ANALYSIS

8.1.1 Very High Evaporator Pressure (Relative to Air Input)

This issue may result from an excessive load, a high cold room temperature, or an improperly sealed compressor air intake. To resolve it, collect excess refrigerant, check for overheating, and inspect the compressor's condition, replacing it if necessary.

8.1.2 Very Low Condensation Pressure

Possible causes include insufficient refrigerant gas, low cold room temperature, a non-hermetic compressor air intake, a blockage in the liquid circuit, or a partially or completely open solenoid valve. Solutions involve locating leaks, completing the refrigerant charge, waiting for system start-up, checking and replacing the compressor if needed, and inspecting and replacing blocked components such as the dehydrator filter, capillary tube, or expansion valve.

8.1.3 Very High Condensation Pressure

If the high-pressure switch cuts out and triggers the “PAL/CA” alarm, the problem could be due to insufficient airflow, air recirculation, very high cold room temperature, a dirty condenser, excessive refrigerant charge (flooded condenser), a failed condenser fan, or air trapped in the cooling circuit. Address these by inspecting airflow, adjusting temperature settings, cleaning the condenser, removing excess refrigerant, repairing the fan, or draining and recharging the cooling circuit.

8.1.4 Very Low Evaporation Pressure

When the low-pressure switch cuts out and the “PAL/CA” alarm is triggered, potential causes include insufficient evaporator airflow, a frozen evaporator, temperature differences in the liquid line, low refrigerant levels, very low condensation pressure, or a failed evaporator fan. Solutions include checking air or water circuits, repairing the defrost system, replacing filters, locating and fixing leaks, adjusting airflow or relocating the unit, and repairing the evaporator fan.

8.1.5 Compressor Fails to Start (No Buzzing Sound)

This issue might result from insufficient power supply, open contacts in control elements, an anti-short cycle timer, an open contactor, a burnt-out contactor coil, or an open internal Klixon. To troubleshoot, inspect the differential switches and fuses, check safety chains and electronic controls, replace defective components, or allow the Klixon to reset and verify power consumption.

8.1.6 Compressor Fails to Start (Intermittent Motor Sound)

The causes could include very low network voltage or a disconnected power cable. Check the line voltage and resolve any voltage drops, and ensure the power cable is properly connected.

8.1.7 Repeated Compressor Stoppage and Start-Up

This problem may stem from high pressure, low regulation differential, insufficient gas, a dirty or frosted evaporator, a failed evaporator fan, a damaged or blocked capillary tube or expansion valve, or an obstructed dehydrator filter. Solutions include verifying the refrigerant charge, addressing leaks, increasing short cycle differential, cleaning the evaporator, repairing or replacing fans, and replacing blocked components.

8.1.8 Compressor Producing Unusual Noise

Unusual noise could be due to loose fixings, insufficient oil, or a defective compressor. Secure loose parts, add oil to the recommended level, or replace the compressor as needed.

8.1.9 Excessive Noise During Operation

If the unit is noisy during operation, it may lack anti-vibration supports. Install the necessary supports to resolve the issue.

8.1.10 Defrosting System Not Functioning

A non-functional defrosting system can result from electrical faults, a non-operational defrost module, a failed solenoid, or regulation failure. Locate and repair electrical issues, inspect defrost module parameters, replace the solenoid if required, and address any regulation problems (Group, 2021, 141).

9 Conclusion

The successful completion of the cold room and freezer installation projects across multiple African countries demonstrates the effectiveness of meticulous planning, technical expertise, and collaborative efforts with partners like UNICEF and the respective Ministries of Health. Despite challenges such as logistical delays, uneven site conditions, and geopolitical risks, the projects achieved their objectives, ensuring reliable vaccine storage solutions.

The work highlights the importance of thorough training for local staff, enabling sustainable operation and maintenance of these facilities. By addressing both technical and managerial aspects, the training programs empower local teams to manage the systems effectively, contributing to the broader goal of improving healthcare infrastructure in underserved regions.

This initiative serves as a model for future projects, emphasizing the value of adaptability, detailed preparation, and teamwork in overcoming obstacles and delivering critical infrastructure that supports global health priorities.

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Pictures

cold and freezer room: