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SUPPLY DIVISION

COLD CHAIN

SUPPORT PACKAGE

PROCUREMENT GUIDELINES

MAINS POWERED COMPRESSION SYSTEM REFRIGERATORS AND FREEZERS

Procurement Guidelines

Mains Powered Compression System Refrigerators and Freezers

Key information for UNICEF staff and partners, ensuring the effective and efficient procurement of Cold Chain equipment.

This module gives guidance to the procurement of mains powered compression system refrigerators and freezers for vaccine storage.

> Always make sure that you have the latest version of this document by checking the CCSP website.

Document Update: January 11, 2021

Suggestions and feedback: sd.coldchain@unicef.org

Contents

Acronyms

CCSP	Cold Chain Support Package
CO	Country Office
DOA	Direct Order Arrangement
ILR	Ice Lined Refrigerator
LTA	Long Term Arrangement
PHC	Primary Health Care
PQS	Performance Quality and Safety
PQT	Prequalification Team
PS	Procurement Services
SD	Supply Division (UNICEF)
SDD	Solar Direct Drive
VC	Vaccine Carrier
WHO	World Health Organization

- ✓ In this document the term “Mains Powered” has the same meaning as “On-grid”.
- ✓ All refrigeration system (equipment) discussed in this document are compression type.
- ✓ *Also, Mains Powered ice lined refrigerator or combined refrigerator/freezer has similar meaning with the following:*

Mains powered compression type refrigerator or combined refrigerator/freezer
PQS listed mains powered refrigerator or combined refrigerator/freezer
PQS prequalified mains powered refrigerator or combined refrigerator/freezer

1 Needs Identification

1.1 Introduction

Refrigerators and freezers are an important link in the temperature-controlled supply chain. The decision to acquire additional Cold Chain equipment should be based on several criteria, most important of which are the current existing storage capacities for vaccines and the anticipated future storage requirements. The procurement of Cold Chain equipment should be based on national policy, Expanded Programme of Immunization (EPI) strategies and according to planned national asset acquisition and replacement policies. Acquiring refrigeration equipment calls for the involvement of EPI managers and logisticians to determine required storage capacities.

1.2 How to Choose Refrigeration Equipment

In areas with an electricity supply of 8 or more hours during a 24-hour period (whether the source is grid and/or generator), the mains powered refrigeration systems are particularly suitable because they exhibit a holdover time of more than 24 hours. This can prevent vaccines from damage during power interruptions or regular outages.

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Measles and Rubella vaccines are inspected by a health worker at a clinic in Bani Alhareth, Sana'a, Yemen on 9 February 2019.

In areas with less than 8 hours of electricity during a 24-hour period, solar-powered refrigeration equipment should be chosen. Solar powered refrigerators and freezers are available as Solar Direct Drive (SDD) refrigeration equipment. In opting for solar-powered refrigerators and freezers, it is important to note that special parameters need to be considered prior to introducing them. System sizing is required for different sites and locations. Refer to the procurement guidelines on Solar Powered Refrigerators and Freezers for further information.

Mains powered Combined Ice Lined Refrigerator/Freezers are refrigerators that include a separate freezer compartment. Depending on the capacity required, it may be necessary to use combined Ice Lined Refrigerator/Freezer equipment or designated ice pack freezers. A decision flowchart for choosing the most suitable option for vaccine storage is given in the WHO PQS manual (Section E003.5).

1.3 Types of Mains Powered Compression Type Refrigeration Equipment

There are four different types of mains powered compression refrigerators and freezers:

a. Mains Powered Refrigerator (without freezer compartment)

The entire unit is used only for keeping vaccines cool at a temperature of +2 °C to +8 °C

b. Mains Powered Combined Refrigerator/Freezer

The unit has two compartments, one for keeping vaccines cool at a temperature of +2 °C to +8 °C and the other for water packs freezing at -20 °C

c. Mains Powered Freezer

Vaccine/water packs freezer: Designed for freezing of vaccines or water packs
Water packs freezer: Designed for the purpose of water pack freezing only

1.4 Mains powered Ice-Lined Refrigerators and Combined refrigerator/freezers

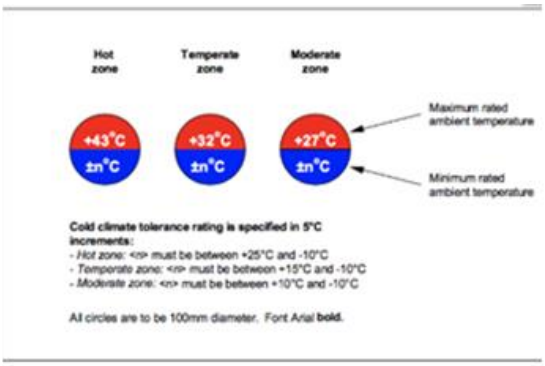
1.4.1 Introduction

Vaccine storage refrigerators and Combined refrigerator/freezers are designed to operate in different climatic conditions and exhibit special characteristics. Majority of the mains powered refrigerators and combined refrigerator/freezers listed in current PQS are high performing, which means these devices can perform at max ambient temperature of +43 °C and at min ambient of +10 °C or less. They are known as Ice-Lined Refrigerators, the internal refrigerator walls are lined with coolant packs/tubes. Coolants can be water or PCM. This ensures that during power outages the vaccine is maintained at the recommended temperature for a specific period. The hold-over time is the time it takes for the temperature inside the refrigerator to rise from its minimum temperature of 2°C to 10°C.[1]

1.4.2 Temperature Stability

An appliance is said to be high performing if it is designed for operation with in an extended ambient temperature range i.e. ≤+10°C min and +43 °C max rated ambient temperature.

High perfroming mains powered refrigerators, freezers and combined refrigerator/freezers listed in current PQS are tested for temperature stability at ambient temperatures of + 43°C in WHO accredited laboratories to ensure that the equipment will perform optimally. They are referred as hot zone appliances.



Temperature zone symbol

PQS prequalified Mains powered refrigerators and combined refrigerator/freezers have excellent temperature recovery qualities. Temperature recovery is the fridge's ability to return to its set operating temperature after being exposed to an elevated temperature. The frequency and duration of door openings will raise the internal temperature of the refrigerator and, depending on the temperature recovery properties this may cause unsafe vaccine storage temperatures.

The temperature recovery in PQS listed refrigerator and combined refrigerator/freezers is very different from domestic refrigerators. PQS prequalified refrigerators and combined refrigerator/freezers are controlled by highly accurate rapid response thermal sensors. Any deviation from the pre-set temperature is registered in good time. For this reason, they do not need to accommodate large loads or contain water bottles to ensure efficient temperature regulation.

Temperature monitoring: Every mains powered refrigerator or combined refrigerator/freezer is supplied with PQS prequalified 30 day electronic temperature logger, with factory-programmed alarms and visual display for monitoring storage conditions in vaccine refrigerators over a 30 day period.

[1] Full description of hold-over time: The time in hours during which all points in the vaccine compartment remain between +2°C and +10°C, at the maximum ambient temperature of the temperature zone for which the appliance is rated, after the power supply has been disconnected.

1.4.3 Spatial temperature differentials exhibited in domestic refrigerators

Temperature differences inside domestic refrigerators are known as 'spatial temperature differentials'. The temperature inside these models varies from one point to another. Spatial temperature differentials can result from a number of factors ranging from the type of insulation to the method of cooling as well as compartment shapes and loads. For example, the temperature on the top shelf may vary from the temperature on the bottom shelf or from the sides or front to back on each shelf. Fan cooling distributes air in the compartment but this does not guarantee uniform temperatures throughout.

1.4.4 WHO-PQS[2] listed cold chain products

WHO-PQS listed Mains powered refrigerators and Combined refrigerator/freezers are specially designed to avoid spatial temperature differentials and ensure uniform temperature distribution - eliminating the possibility of placing vaccine is in a warm or freezing location.

Freeze protection classification: WHO-PQS listed Mains powered refrigerators and combined refrigerator/freezers are classified as Grade A, B or C based on the number of user interventions required to ensure freeze protection. This is not applicable for freezers.

Grade A

Majority of the PQS listed Mains powered refrigerators and combined refrigerator/freezers are Grade A, with user-independent freeze protection (UIFP) feature, which means when the appliance is used within its nominated temperature range (upper hot zone temperature +43°C and minimum rated ambient temperature) there is no intervention required by the user to ensure that the vaccines will not be exposed to freezing temperatures outside of the acceptable temperature range, whatever the position of the vaccines in the vaccine storage compartment.

2 Refrigerators and Freezers supplied by UNICEF SD

UNICEF Supply Division (SD) supplies refrigerators and freezers that comply with the quality requirements set by WHO, documented in the WHO PQS catalogue. UNICEF SD procures WHO pre-qualified refrigerators and freezers via Long Term Arrangements (LTAs) The following compression system refrigerators and freezers are supplied by UNICEF SD (LTA, 2018), available from various manufacturers:

	Equipment type	Volume category	Remarks
1.	Mains powered refrigerators or Combined refrigerator/freezers	<30L ≥30, <60L ≥60, <90L ≥90, <120L ≥120L	Every equipment is supplied with PQS prequalified voltage stabilizer and 30-day electronic temperature logger
2.	Solar direct derive refrigerators or Combined refrigerator/freezers	<30L ≥30, <60L ≥60, <90L ≥90, <120L ≥120L	Every equipment is supplied with PQS prequalified 30-day electronic temperature logger

[2] WHO PQS is the WHO product quality system. PQS stands for Performance, Quality and Safety.

3. Mains powered Vaccines/water packs freezers	≥90, <120L ≥120L	Every equipment is supplied with PQS prequalified voltage stabilizer and thermometer with digital display
4. Mains powered water packs freezers	≥120L	Every equipment is supplied with PQS prequalified voltage stabilizer and thermometer with digital display
5. SDD water packs freezers	≥30, <90L	Every equipment is supplied with thermometer with digital display

NB: An appliance is said to be high performing if:

- Mains powered refrigerator or Combined refrigerator/freezer is: Tested for Grade A, with max rated ambient temp of +43°C and min +10°C or less
- Solar direct derive refrigerator or Combined refrigerator/freezer is: Tested for Grade A, with max rated ambient temp of +43°C and min +10°C or less
- Mains powered vaccines/water packs freezer is with max rated ambient temp of max +43°C
- Mains powered water packs freezer is with max rated ambient temp of +43oC
- SDD water packs freezer is with max rated ambient temp of +43°C

3 Budgeting

For information about budgeting for procurement, refer to the General Procurement Guidelines.

4 Ordering

4.1 Starting the Process

Refer to the General Procurement Guidelines and the UNICEF SD Procurement Services website for general guidance on how to order Cold Chain products and services. In the event that the General Procurement Guideline does not provide sufficient information, please contact the Supply Division Procurement Services for specific queries.

4.2 Delivery Lead Times

Refer to the section 'When to Order' in the document 'General Procurement Guidelines'.

4.3 Technical Considerations

a. Generator

In some locations, the electricity supply for the refrigerators and freezers is not stable and reliable. In these cases, solar direct drive refrigeration systems are recommended, or a standby generator should be in place. T

b. Voltage Stabilisers

Refrigerators and freezers have components that are sensitive to power fluctuations. Intermittent national grid power supply, as well as stand-by generators during start-up on heavy load pick-up and shut down, resulting in transients that contribute to system failure. This creates high surges that are detrimental to sensitive components and accessories, leading to their failure. Therefore, UNICEF supplies a voltage stabiliser with every mains powered equipment.

c. Weight and Volume Factors

Estimated weights and volumes of refrigerators and freezers are listed in the UNICEF Supply Catalogue (click on equipment item for detailed information).

4.4 Ordering Spare Parts

When ordering refrigerators and freezers, the manufacturers' guidelines should be observed in ordering spare parts and consumables. The situation in some countries is such that spare parts cannot be sourced locally at short notice. In these circumstances it may be prudent to order essential spare parts together with the equipment. Some countries have a maintenance workshop tasked with the maintenance and repair of Cold Chain equipment. Such a workshop may keep a stock of essential spare parts, which facilitates a rapid response in case of equipment breakdown. Refer to the Manufacturers' Product Documentation/PQS equipment data sheet/ SD list of spare parts for details on recommended spares.

Maintenance of a refrigerator in Haiti. Common spare parts for compressor type refrigerators include compressors and thermostats.

5 Transport Handling

Transport handling for compression system refrigerators and freezers requires caution. In the unlikely event of oil circulation in the refrigeration circuit of a compression refrigerator and freezer system, the equipment will be rendered inoperative. Compression refrigerators and freezers should always be transported in the upright position to avoid the oil in the compressor getting into the system cycle. After transportation of these products, a minimum of three hours should be allowed for the stabilisation of the oil before connecting to the power supply.

The necessary local resources for transportation, manpower and time should be included in the planning process. For further information on transport issues refer to the document General Procurement Guidelines.

6 Installation

The efficiency of refrigeration cooling systems depends on dissipation of heat from the condenser. For the efficient operation of refrigerators and freezers, it is recommended that they are installed with a minimum space of 200 mm from the wall to allow for adequate air circulation. This also allows ample space for technicians when they carry out preventive maintenance.

7 Commissioning

Equipment commissioning is a formalised process through which equipment is tested, demonstrated and officially accepted by the owner. Equipment commissioning needs to be conducted to ensure that equipment is functioning properly before it is used. In the case of Cold Chain equipment other than cold

and freezer rooms, there is no formal commissioning procedure. The forwarding agent delivers the goods to the destination, after which the beneficiary takes care of in-country distribution and installation.

8 User Training

In order for refrigerators and freezers to deliver their intended services, staff using the equipment need to be trained in using the equipment correctly. Training should include routine and preventive maintenance actions, including:

a) temperature monitoring
b) cleaning of the equipment
c) fault reporting.

The User Manual supplied by the manufacturer is an important source of information. Refer to the Manufacturers' Product Documentation for further information on correct use of the equipment and the WHO vaccine management handbooks.

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A health worker packs icepacks into a large cold box, which will be filled with vaccines, ahead of a rural vaccination drive in Koch county, at the hospital in Bentiu, South Sudan, Friday 5 May 2017.

9 Maintenance

Maintenance serves the purpose of keeping refrigerators and freezers in good working order throughout their lifetime. A distinction is made between corrective and preventive maintenance.

The following functions should be carried out periodically to ensure efficient operation of vaccine refrigerators and freezers.

a) Regular dusting of the evaporator and compressor
b) Defrosting when ice build-up is noticed on the evaporator
c) Cleaning of door seals and application of talc power
d) Periodic greasing of hinges

The frequency of these maintenance actions will depend on local circumstances. In addition, supplier specific preventive maintenance tasks should be followed. Refer to the Manufacturers' Product Documentation for further information on routine maintenance.

10 Complaints Handling

For Complaints Handling procedures refer to the General Procurement Guidelines.

11 Warranty

For Warranty issues refer to the General Procurement Guidelines.

12 Decommissioning

Decommissioning refers to the process of writing-off and physically disposing of equipment that is no longer cost-effective. Countries are advised to adhere to national public sector procedures for the correct disposal of health sector physical assets.

Annex 1: Additional Resources

Links to additional resources specifically on Mains powered compressor type refrigerators and freezers.

Description	Source
Technician's Handbook for Compression Refrigerators, Part A: Servicing and Repair Techniques	Technet-21 website
Technician's Handbook for Compression Refrigerators, Part B: Faults and Fault Finding	Technet-21 website
Handbook for Vaccine and Cold Chain Handlers	UNICEF website (India)
The UNICEF supply catalogue, Cold Chain Equipment	https://supply.unicef.org/all-materials/cold-chain-equipment.html)
WHO Vaccine Management Handbook Module VMH-E3-01.1	https://apps.who.int/iris/bitstream/handle/10665/255749/WHO-IVB-17.06-eng.pdf?sequence=1

Note: Users of this manual are invited to suggest additional resource materials, to add to this list.

Annex 2: Record of Revisions

Date	Description	By
April 1, 2012	First draft of this manual, by UNICEF SD\HTC\Cold Chain Unit	GK,DH,AS
June 26, 2014	Second draft	BR
August 9, 2014	Updated, minor corrections	BR
October 28, 2014	Updated, minor corrections	BR
December 18, 2020	Updated with technical information including but not limited to; “Acronyms”, “1.3 Types of Mains Powered Compression Type Refrigeration Equipment“, “1.4 Mains powered Ice-Lined Refrigerators and Combined refrigerator/freezers”, “2 Refrigerators and Freezers supplied by UNICEF SD” sections.	TY
December 18, 2020	Updated with new web-links, minor format changes, updated contents page.	SAK