Compression and Absorption Type Refrigerators and Freezers for Vaccine Storage

This document contains the following guidance related to Compression and Absorption Type Refrigerators and Freezers for Vaccine Storage.

- Procurement Reference Guide
- Technical Reference Guide

Procurement Reference Guide

This section provides specific commercial guidance and related references to UNICEF Country Offices (CO) and Procurement Services (PS) partners for ordering of Compression and Absorption Refrigerators and Freezers.

Technical details are provided separately in the Technical Reference Guide for Compression and Absorption Refrigerators and Freezers.

All UNICEF procurement of compression and absorption refrigerators and freezers must be done through Supply Division (SD). In addition, Long Term Arrangements (LTAs) for direct ordering are also available for use by COs for compression type refrigerators and freezers.

Preparing for the procurement of Compression and Absorption Refrigerators and Freezers

a. Assess the suitable equipment guidance on technical considerations in the procurement context can be found in the Technical Reference Guide for Refrigerators and Freezers.

b. Calculating timelines and cost for receiving Compression and Absorption Type Refrigerators and Freezers

UNICEF Supply Division has standard tools to assist with identifying a realistic arrival at point of unloading prior to ordering.

Estimated Weight and Volume of the equipment are stated in the item specifications in the UNICEF Supply Division Supply Catalogue.

Standard supplier lead times for goods ready for shipment are up to **8 weeks -** from the supplier's receipt of the UNICEF Purchase Order to delivery to the port of shipment (INCOTERMS FCA).

If the project is time critical you may contact Supply Division/Cold Chain Unit to obtain more specific information on estimated supplier lead times at a given point of time.

Please contact the Supply Division Cold Chain Unit for any related queries.

Technical Reference Guide

This section provides specific technical guidance and references to UNICEF Country Offices for Compression and Absorption Refrigerators and Freezers in a procurement context. Procurement related guidelines are provided in the Procurement Reference Guide for Compression and Absorption Type Refrigerators and Freezers. The content of this document refers to both compression and absorption refrigerators and freezers unless indicated otherwise.

I. Special Characteristics of Vaccine Refrigerators.

a. Ice-lining

Vaccine storage refrigerators are designed to operate in different climatic conditions and exhibit special characteristics**.** They are known as Ice-Lined Refrigerators (ILRs). The internal refrigerator walls are lined with ice packs/tubes. This ensures that during power outages the vaccine is maintained at the recommended temperature for a specific period of time.

b. Temperature stability

ILRs are tested for temperature stability at ambient temperatures of 27°C, 32°C and 43°C in WHO accredited laboratories to ensure that at field conditions the equipment will perform optimally. The three temperature zones are referred to as *cold*, *temperate* and *hot* zones - corresponding to the maximum temperatures above.

ILRs 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 and methods employed on the refrigerator, this may cause unsafe vaccine storage temperatures.

The temperature recovery in an ILR is very different from domestic refrigerators. ILRs are controlled by high accuracy thermometer sensors with fast responses and any deviation from the pre-set temperature is sensed in a timely manner. For this reason ILRs do not need to accommodate large loads or contain water bottles to keep the refrigerator's thermal mass higher to ensure efficient temperature regulation.

c. Spatial temperature differentials

Temperature differences within domestic refrigerators are known as 'spatial temperature differentials'. The temperature inside these models varies from one point to another. Temperature spatial 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. Even though a fan might distribute the air within a compartment, temperatures are generally not uniform throughout.

d. WHO-PQS[1] listed cold chain products

WHO-PQS listed ILRs are specially designed to avoid spatial temperature differentials and ensure uniform temperature distribution - eliminating the chance of placing vaccines in a warm or freezing location. Should the potential exist to compromise vaccine potency due to contact with cold internal cabinet walls, the WHO prequalification performance test protocol requires wire baskets to be part of the ILR for it to become pre-qualified for safe storage of vaccines.

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

II. Handling requirements for Compression and Absorption Refrigerators and Freezers

a. Transport handling

Transport handling for compression refrigerators 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. However, this does not apply to Absorption Refrigerators and Freezers.

b. Installation of refrigerators and freezers

The efficiency of refrigeration cooling systems depends on dissipation of heat from the condenser. For the efficient operation of both Compression and Absorption Refrigerators and Freezers, it is recommended that they should be 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.

c. Maintenance

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

1. Regular dusting of the evaporator and compressor
2. Defrosting when ice build-up is noticed on the evaporator
3. Cleaning of door seals and application of talc power
4. Periodic greasing of hinges

In addition, supplier specific preventive maintenance tasks should be followed.

d. Choice of 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 ILRs are particularly suitable because they exhibit a holdover time of more than 24 hours at +43 °C ambient temperature. This can prevent vaccines from damage during power interruptions or regular outages.

In areas with less than 8 hours of electricity during a 24-hour period, either absorption or solar-powered refrigeration units should be chosen. As first choice, solar powered refrigerators are preferred (Solar Direct Drive or conventional battery powered). For Absorption Refrigerators the decision will rest on the type of fuel to use. If gas is available, gas-fuelled Absorption Refrigerators are the preferred option, followed by kerosene-fuelled. Gas-fuelled Absorption Refrigerators are cleaner to use, easier to maintain and regulate temperature with running costs that are close to electric refrigerators.

Where gas is not available, kerosene-fuelled refrigerators are the next best option. However, they require more maintenance, are less reliable and are poor at temperature maintenance.

As a preference for Solar-powered refrigerators option in the above scenario, it is important to note that special parameters need to be considered prior to introducing them. This is important, as system sizing is required for different sites and locations. A decision also needs to be taken on what equipment is needed to freeze ice packs for keeping vaccines cool in vaccine carriers during outreach services. Some types of refrigerators 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 can be accessed in the Quick Reference Repository.

e. Note on Absorption Refrigerators

Absorption Refrigerators are poor in efficiency and it is difficult to control temperature within the recommended parameters. They use heat source (e.g. gas, kerosene-fuelled flame) to provide the energy needed to drive the cooling system. Absorption Refrigerators are an alternative to regular compression refrigeration systems where electricity is unreliable or intermittent. Currently, in parts of the world where there is no reliable electrical supply, vaccines are mostly stored in the absorption refrigerator systems.

Failures related to Absorption Refrigerators

a. Leaks

When a cooling unit begins to rust, and as a result leak, the ammonia gas is lost first. Most often, the pungent smell of the gas is evident. However in a well-ventilated room, particularly when the door of the room is open, or where the leak is small, there may be little or no smell. In these circumstances a boiling sound at the back of the refrigerator may be heard. This means the hydrogen gas has also leaked out and the water is now boiling. Ammonia smells or loud gurgling sounds from the refrigerator are indicators that the refrigerator cooling unit is leaking.

b. Running while not levelled

Scenario 1:

If the refrigerator is run for an extended period while not level, the cooling unit water will not flow into the boiler. As a result the boiler gets excessively hot and can bake the rust inhibitor. This will in turn block the small, thin tubes in the boiler, and the aqua-mix flow will stop. If the refrigerator is kept running under these circumstances the boiler tube will get extremely hot and eventually crack open. If this happens, a yellow powder around the burner area may be visible - indicating that the cooling unit's rust inhibitor is leaking and will consequently fail to cool.

Scenario 2:

The second biggest problem with running the refrigerator unlevelled is that water moves around the pipes and flows down the coils at the back into the main storage tank. The pipes at the back all slope down from side to side. When the refrigerator is not level, one direction of the coil will be flowing up-hill and the water flow will stop. When this happens there is no flow to the boiler section and the water in the boiler pipe boils dry. The rust inhibitor dries up and blocks the boiler tube. If the unit is kept running the boiler pipe will get so hot that it will crack from the gas pressure inside the coils. At this point, the cooling unit stops working.

Always level the refrigerator as best as you can with the help of the spirit level. Most failures associated with Absorption Refrigerators are as a result of having been run unlevelled, thus cracking the boiler. This can be a very costly mistake.

c. Repair of Leaks on cooling units

This is an exercise which requires highly specialised technical expertise, accurate ratios of the water and hydrogen and ammonia gases which constitute the cooling medium, and specialised repair equipment. The process can therefore not be carried out locally at the country level. A complete replacement of the cooling unit (for the models for which the unit is replaceable) is the only remedy that can be carried out at a country cold chain workshop level

d. Fuel consumption

Kerosene Absorption Refrigerators procured through SD consume approximately 0.8 to 1 litre of kerosene or 0.45 and 0.8 kilogramme of gas daily. They emit an odour of burning kerosene, occasionally catch fire, and need regular re-fuelling - which is a recurrent and permanent operating cost. Timely replacement of wicks for the kerosene models, and replacement of the

thermocouple for the gas models, is also necessary. The product (especially the kerosene model) is often unreliable in maintaining the required stable temperature due to difficulties in ensuring the constant adjustment of the flame and the cleaning of the flue. There is also a great risk of freeze sensitive vaccines being exposed to lower temperatures than recommended - subsequently compromising the vaccines' potency.

Moreover, kerosene Absorption Refrigerators are environmentally detrimental and contribute to global warming. Estimates provided by United Nation Environment Program- Division of Technology, Industry and Economics (UNEP-DTIE) indicate there are approximately 100,000 kerosene refrigerators currently in use around the world for vaccine cooling purposes. One kerosene refrigerator is estimated to emit 733 - 916 kgs of CO2 into the atmosphere annually, or 73-91 million kgs of CO2 each year from 100,000 refrigerators.

The current stock of kerosene refrigerators are aging. Direct-drive solar systems may prove to be the most viable alternative for the replacement of many of these units. Environmental pollution including the depletion of the ozone layer and greenhouse effect has become a social environmental problem and the effects of ammonia as a refrigerant has come under focus and is being re-evaluated.

Please contact the Supply Division Cold Chain Unit for any related queries.