GUIDE FOR

CARRIAGE OF INTEGRAL REFRIGERATED CONTAINERS ON BOARD SHIPS

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American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862

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Foreword

This Guide provides the evaluation procedure and technical requirements to verify the eligibility of a Container Carrier for the optional notation ✠ **IRCC-SP xxx/xx** (Integral Refrigerated Container Carrier – Stowage Positions).

This Guide becomes effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.

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SECTION 1 Introduction

1 General

The provisions of this Guide apply to container ships equipped to transport integral refrigerated containers. Where cargo is carried in refrigerated containers of plug-in or integral types which have their own individually mounted refrigeration machinery, hence requiring shipboard electrical power supply and in some cases the cooling water supply for the condensers, and where fitted, the associated temperature monitoring and control system, the *Record* will give the total number of refrigerated containers onboard, the total design load in kW and the type of temperature monitoring and control system installed.

Section 2 of this Guide provides the technical requirements for the optional notation: ✠ **IRCC-SP xxx/xx (Integral Refrigerated Container Carrier – Stowage Positions)** for container ships. When requested by the Owner, the systems and arrangements for stowage of integral refrigerated containers may be verified for compliance with the requirements outlined in Section 2 of this Guide.

The Class Notation ✠ **IRCC-SP xxx/xx** is supplemented by two figures, the first of which stands for the number of certified integral refrigerated container stowage positions and the second figure for the percentage of containers carrying fruit/chilled cargoes.

For example, ✠ **IRCC-SP 940/35** designates that the ship is capable of the simultaneous carriage of 940 integral refrigerated cargo containers arranged on deck and/or in container holds, and a maximum of 35% of those cargo containers may be loaded with fruit or chilled cargoes. The number of integral refrigerated containers is based on FEU (forty foot equivalent units). Details concerning other container sizes, stowage positions and special conditions will be stipulated in the Class Record.

The requirements in this Guide are in addition to the classification requirements for ships contained in the ABS *Rules for Building and Classing Steel Vessels (Steel Vessel Rules)*.

3 Definitions

Integral Refrigerated Container. A standard container with a self-contained refrigeration system, located within the outer dimensions of the container, which can be driven by electrical power fed from an external power supply. The refrigeration system may be either a “clip-on” or an integral type of cooling unit.

Container Plug-in Point. An electrical socket located at each container location on deck and each cell location below the deck, which is in accordance with ISO 1496-2.

Hold Space. An enclosed space containing refrigerated containers. The containers are restrained within cell guides. If the ship is “open hatch” type, the hold space refers to the space below the hatch coamings.

Container Cell. This is the position of an individual container. It is typically located within a set of vertical cell guides and is normally enclosed by transverse stringers located above and below the container.

5 References

The following Rules, Guides, Codes and Standards are referenced in this Guide:

- ABS *Rules for Building and Classing Steel Vessels (Steel Vessel Rules)*

7 Vessels Not Built Under Survey

Vessels intended for the carriage of integral refrigerated containers, which have not been constructed under survey by the Surveyors, but which have been subsequently surveyed at the request of the Owners, satisfactorily reported upon by the Surveyor, and which comply with the requirements of this Guide, will be distinguished in the *Record* by the notation, as appropriate, but the mark ✠ signifying survey during construction will be omitted.

9 Alternative Designs

Design arrangements modified from those which have already been proved suitable in service on board ships are subject to ABS's approval. For these installations and arrangements, ABS may require additional requirements regarding the documentation to be submitted for approval and the extent of testing.

If this Class Notation is applied for ships other than container ships, it will be given special consideration.

SECTION 2 Technical Requirements for Notation ✠ IRCC-SP xxx/xx *(1 May 2017)*

1 Plans and Data to be Submitted *(1 May 2017)*

The following plans and supporting information on the hold ventilation systems and the electrical supply to the container plug-ins are to be submitted.

1.1 Ventilation Arrangements and Calculations

- All container cargo hold and weather deck ventilation system diagrams showing all air ducting and air distribution system, details of air inlets and outlets (including type, size and location), details of mechanical ventilation fans including duty point at design conditions, and details showing the means of protection against water ingress
- Power consumption of all ventilation fans
- Locations of all dampers, louvers, and remote stop control locations for all fans
- Proposed test plan to measure ventilation distribution and flow volume

1.3 Hold Space Plans

- Stowage plan showing all integral refrigerated container stowage positions for designated container sizes
- Personnel access arrangements including access to containers for repairs
- Location and details of hold temperature measurement instruments

1.5 Electrical Plans

- Container power socket details and arrangements for both deck and hold space refrigerated containers
- Electrical load calculations for all refrigerated cargo containers and supporting equipment, including ventilation fans, see Subsection 2/13
- Details showing electrical equipment installation in the container holds
- List of monitored and alarm points

1.7 Other Plans

- Plans demonstrating compliance with the *Steel Vessel Rules* for container ships will also be required.
- Stowage arrangement of containers including stacking loads

3 Design Conditions *(1 May 2017)*

The container refrigeration units carried on board must be fully functional at ambient temperatures up to 50°C.

The design conditions herein are based on the integral refrigerated containers being at their predetermined carrying temperature at the time the containers are loaded on board.

The container hold ventilation systems are to be designed based on the size, number and type of refrigerated containers and the types of cargo to be carried. The ventilation system is to be capable of removing the heat from each refrigerated container cell and maintaining the hold temperature at or below the maximum hold temperature.

The capacity of supply air is to be calculated based on the following conditions:

- Ambient air condition: 35°C, (95°F) Relative Humidity 70%
- Maximum air temperature in container holds: 45°C (113°F)
- Maximum seawater temperature: 32°C (90°F)

Alternative conditions will be specially considered upon request from the Owners and/or builders.

5 Air Supply for Container Holds

5.1 Air Supply Calculation for Container Holds Designed for the Carriage of Integral Refrigerated Containers using Air-cooled Condensers

The below values for supply air may be used for guidance:

- 3100 m^3/h per 20-foot integral refrigerated container
- 4500 m^3/h per 40-foot integral refrigerated container

Alternatively, the supply air volumetric flow to the container holds may be calculated by applying the formula below. A simultaneous factor need not be applied.

$$\dot{V}_C = \left(\dot{W}_{RC} + \dot{Q}_{FC} + \dot{W}_F\right) \times \frac{v_a}{\Delta h}$$

where

$\dot{V}_C$ = supply air capacity per container stowage position, in m^3/s

$\dot{W}_{RC}$ = power demand per integral refrigerated container depending on cargo mix, See Appendix 1, Figures 1 and 2, in kW.

$\dot{Q}_{FC}$ = respiration heat of fruit cargoes per container, in kW

$\dot{W}_F$ = power demand of cargo hold supply air fans per container, in kW

v_a = specific volume of incoming air (see design conditions above), in m^3/kg

Δh = change in enthalpy between exhaust air and inlet air, in kJ/kg

= $h_{45} - h_{35}$

5.3 Air Supply to Container Holds Designed for the Carriage of Integral Refrigerated Containers using Water-cooled Condensers

Air supply calculations to the container holds are to be based on the following heat emission values:

- 1.5 kW per 20-foot integral refrigerated container
- 2.1 kW per 40-foot integral refrigerated container

Unless stipulated otherwise, a minimum of 8% of the container refrigeration units are considered to operate without water cooling.

The below air supply values may be used for guidance:

- 460 m^3/h per 20-foot integral refrigerated container
- 700 m^3/h per 40-foot integral refrigerated container.

7 Air Ventilation Systems

7.1 Air Ducting and Air Distribution *(1 May 2017)*

The integral refrigerated containers are to have an air ducting and air distribution system which provides adequate heat dissipation regardless of the loaded condition. Hot spots are to be avoided.

Dedicated supply air ducts and fans are to be arranged for each container stack. For the outermost stacks, one supply air duct and fan may serve supply air to the outermost two or three stacks. A maximum of 16 integral refrigerated containers may be served by one supply air fan.

For water cooled condenser units (2/5.3 above), the container hold ventilation system may be reduced to two air ducts with fans and the supply air outlets directed to the lower part of the container hold.

Supply air to the container holds shall be directed to the lower part ($^1/_3$ height) of each container refrigeration unit. For water cooled condenser units (2/5.3 above), air distribution to each individual container need not be provided.

Where the simultaneous stowage of 8.5-foot and 9.5-foot height containers in holds is desired, the supply air outlets in the holds shall be provided with adjustable openings to provide direct supply air to the lower part of the container refrigeration units irrespective of the stowage pattern.

Provisions to minimize the air flow resistance between container refrigeration units and exhaust air outlets of container holds shall be made. Restrictions of air flow caused by interferences (walkways etc.) are to be kept to a minimum.

Arrangements allowing the rapid shutdown and closure of the ventilation fans and closure of the ventilation openings to each hold shall be provided in case of fire.

7.3 Air Inlets and Outlets on Deck

The arrangement of air inlets and air outlets of cargo hold ventilation systems shall achieve heat dissipation from container holds even in heavy weather. If the air supply inlets must be provided with weathertight closures in accordance with LLC 66/78, protection against water ingress, such as water traps or droplet separators, shall be provided. Other arrangements may be considered for acceptance, such as arrangements in locations protected against green water.

Short-circuiting (recycling) of air supply is to be prevented by the positioning of air inlets and air outlets. Consideration of heat added from the deck-stowed containers into the cargo hold in addition to the effect of warm exhaust air impinging on deck-stowed containers shall be accounted for in the design.

The design air velocity in exhaust air outlets shall not exceed 10 m/s. Air velocities up to 13 m/s may be accepted provided suitable arrangements for access doors to container holds allowing safe handling under any excess pressure condition inside container holds (e.g., by means of air locks or other suitable arrangements) are designed.

7.5 Supply Air Fans for Container Holds *(1 May 2017)*

Supply air fans are to be designed so that they are capable of being operated simultaneously with the weathertight covers at the exhaust air outlets on one side closed (i.e., starboard or port side). Supply air fan motors must be capable of being replaced with the ship in any loaded condition. A minimum of one spare supply air fan motor, of each type, is to be kept on board.

7.7 Heat Dissipation from Integral Refrigerated Containers Stowed on Deck

Natural air convection is considered sufficient for the heat dissipation from the first and the second tier of containers stowed on deck. Stowage positions for integral refrigerated containers arranged on the third tier will be specially considered.

9 Cooling Water Systems *(1 May 2017)*

For containers using water-cooled condensers, cooling water pipes, valves and fittings are to meet the requirements of Part 4, Chapter 6, "Piping Systems" of the *Steel Vessel Rules*. Cooling water systems, including temperature control systems, are to be so designed that specified temperatures at condenser inlets can be maintained under all operating conditions. The total cooling water capacity is to be covered by at least two cooling water pumps each designed for 100% of total capacity and two heat exchangers each designed for at least 60% of the total capacity.

Isolation valves are to be provided in the cooling water inlets and outlets from each container hold. Automatic vents and manual test valves are to be provided at the highest point of cooling water outlet pipes arranged in each container hold. Drains from vents are to be led to the container hold bilge via drain pipes.

Continuous cooling water flow in the piping systems at partially loaded condition (e.g., by suitable re-circulation/bypass arrangements or speed-variable cooling water pumps) are to be provided. The maximum cooling water velocity through each condenser is not to exceed manufacturer's recommendations.

Automatic replenishing of cooling water from a storage tank is to be provided to the expansion tank. Expansion tanks are to be fitted with vents, drains, level indicators, and low level alarms.

Shell connections are to be in accordance with the requirements of 4-6-2/9.13 of the *Steel Vessel Rules*. If the elevation of the condenser relative to the light water line is such that the manufacturer's recommended back pressure cannot be maintained in the overboard discharge line, then the overboard valve is to be of a spring loaded type.

11 Access to Containers for Monitoring and Repairs

Means are to be provided to allow personnel safe access to container holds taking into consideration the effect of over pressure or vacuum in container holds due to ventilation. Usage of pressure relief or vacuum relief devices, or airlocks, may be required.

Sufficient clearance space is to be provided around integral refrigerated containers stowed on deck and in container holds to allow monitoring and repairs, including compressor replacement. A minimum width of 600 mm is considered sufficient. In cargo holds, walkways are to be arranged in front of the container refrigeration units to simplify monitoring. On deck, safe means of access is to be provided for integral refrigerated containers stowed in any elevated tier (e.g., by means of fixed platforms or lashing bridges).

13 Electric Systems

13.1 Electrical Power Supply

In addition to the requirements of Part 4, Chapter 8, "Electrical Systems" of the *Steel Vessel Rules* and ISO 1496-2 Part 9 – Electrical Aspects of Thermal Containers, the below requirements shall be followed.

The integral refrigerated container sockets and the fans for corresponding cargo holds are to be considered as secondary essential equipment, see 4-8-1/7.3.3 of the *Steel Vessel Rules*.

The power demand for integral refrigerated containers is to be calculated based on a cargo mix as indicated in Appendix 1, Figures 3 and 4. The percentage in fruit or chilled cargo containers is not to be less than 20% and is to be in any case agreed between ship owner and shipyard.

Electrical components provided within sub-distribution systems may be designed for different power demand per FEU/TEU. The power demand may be calculated on the basis of ship owner's experiences with specific trades and cargo pattern where agreed by ABS.

The power demand for the cargo hold ventilation is to be calculated separately.

13.3 Generator Capacity *(1 May 2017)*

Electrical power is to be provided from at least two generating sets. The capacity of the generating sets is to be such that, in addition to the consumers needed to provide for the operation of the services essential for the propulsion and safety of the ship and services for providing minimum comfortable conditions of habitability under the ambient conditions specified in Subsection 2/3, the following conditions are met:

Aggregate capacity of the generators is to be sufficient to supply power to all of the integral refrigerated cargo container electrical power sockets and the cargo hold fans in addition to meeting other power demands under maneuvering conditions. With any one generator inoperable, the remaining generator(s) are to be capable of supplying sufficient power to all refrigerated container sockets and cargo hold fans under normal seagoing conditions, in addition to meeting other power demands to ensure the operation of the essential services and services for minimum comfortable conditions of habitability as per 4-8-2/3.3.1 of the *Steel Vessel Rules*.

Dependent on the electric power available after a black out, gradual restarting of the integral refrigerated containers is to be possible from a central location.

13.5 Electrical Installation *(1 May 2017)*

Electrical equipment installed in the cargo holds is to be protected from mechanical damage. All electrical equipment in the cargo holds is to have IP55 enclosure.

The electric power supply to integral refrigerated container sockets is to be galvanically isolated from the ship mains to avoid any influence in case of insulation faults.

A simultaneous factor for group supply cables for container sockets and for accessory transformers may be agreed in individual cases. Sub-distribution boards for container sockets are to be supplied independent of each other to minimize the influence on the cargo in case of a failure. The number of container sockets connected to one final circuit is not to exceed 10.

15 Monitoring, Alarms, and Indicators *(1 May 2017)*

The power supply to distribution boards for integral refrigerated containers and cargo hold fans is to be displayed locally.

Failure of the power supply for refrigerated container circuits and for each cargo hold fan shall be alarmed. A common alarm for each distribution board is satisfactory.

When more than 150 integral refrigerated container stowage positions are intended for one vessel, the vessel must be equipped with a remote condition monitoring system conforming to a recognized standard (e.g. ISO 10368 Freight Thermal Containers – Remote Condition Monitoring).

All alarms shall be locally displayed and at a manned control station. The alarms are to be integrated with the general ship's alarm system. Alarms shall give an audible and visual warning.

This Guide does not cover the alarm and monitoring requirements fitted to the containers.

17 Fire Protection *(1 May 2017)*

Cargo holds of vessels of 2,000 gross tonnage and upwards are to be protected by a fixed gas fire extinguishing system complying with the provisions of 4-7-3/3 of the *Steel Vessel Rules* or by a fire extinguishing system which gives equivalent protection.

19 Bilge and Drainage Arrangement

The bilge and drainage system for cargo holds is to be in accordance with 4-6-4/5.5 of the *Steel Vessel Rules*.

SECTION 3 Survey Requirements

1 Surveys During Construction

Where optional ABS notation ✠ **IRCC-SP xxx/xx** is requested, the systems and equipment that are installed onboard the vessel are to undergo trials to demonstrate their capability as applicable. Measurements and tests are to be carried out in the presence of the Surveyor.

1.1 Testing of Air Duct Systems

Prefabricated air ducts are to be individually tested at the manufacturer's shop to the following extent:

- Measurement of air capacity at the inlet openings.
- Measurement of air distribution at the air outlets. The maximum deviation of air flow at each outlet is to be ±10% of the rated flow.

Air ducts which form an integral part of the ship's hull are to be tested in place to the same extent as prefabricated ducts.

1.3 Inspection and Testing of Related Systems

Measurement of air capacities at all cargo hold exhaust air openings, while all fans used for the air circulation and fresh air ventilation of cargo spaces carrying integral refrigerated containers are run simultaneously, shall be taken. The maximum air velocity measured at the face of the louvers is to be in line with the requirements set out in 2/7.3. A maximum deviation of 10% may be accepted from the calculated value.

Verification of unrestricted function of hold ventilation systems with exhaust air outlets closed on one side (starboard side or port side), see 2/7.5.

The air circulation/distribution pattern in the refrigerated container cargo holds is to be checked to verify that there are no areas of insufficient flow.

Monitoring, alarm, and indicator systems described in Subsection 2/15 are to be tested with regard to correct function as part of the vessel's central alarm and monitoring system during construction.

Cooling water piping systems are to be subjected to a tightness test under operational conditions. Cooling water flow rate and velocity through the condensers are to be measured for compliance with Subsection 2/9.

3 Surveys After Construction

At Periodical Surveys for Machinery, all ventilation, water cooling, electrical distribution/installation, monitoring, alarm, automatic control, fire protection, and bilge systems are to be examined and tested in accordance with Sections 7-6-2 and 7-8-1 of the ABS *Rules for Survey After Construction (Part 7)*.

Arrangements for access specified in Subsection 2/11 of this Guide are to be examined and found in good working order.

APPENDIX 1 Power Demand for Mixed Cargo

FIGURE 1
Electrical Demand for Ventilation System based on 40-Foot EU Containers

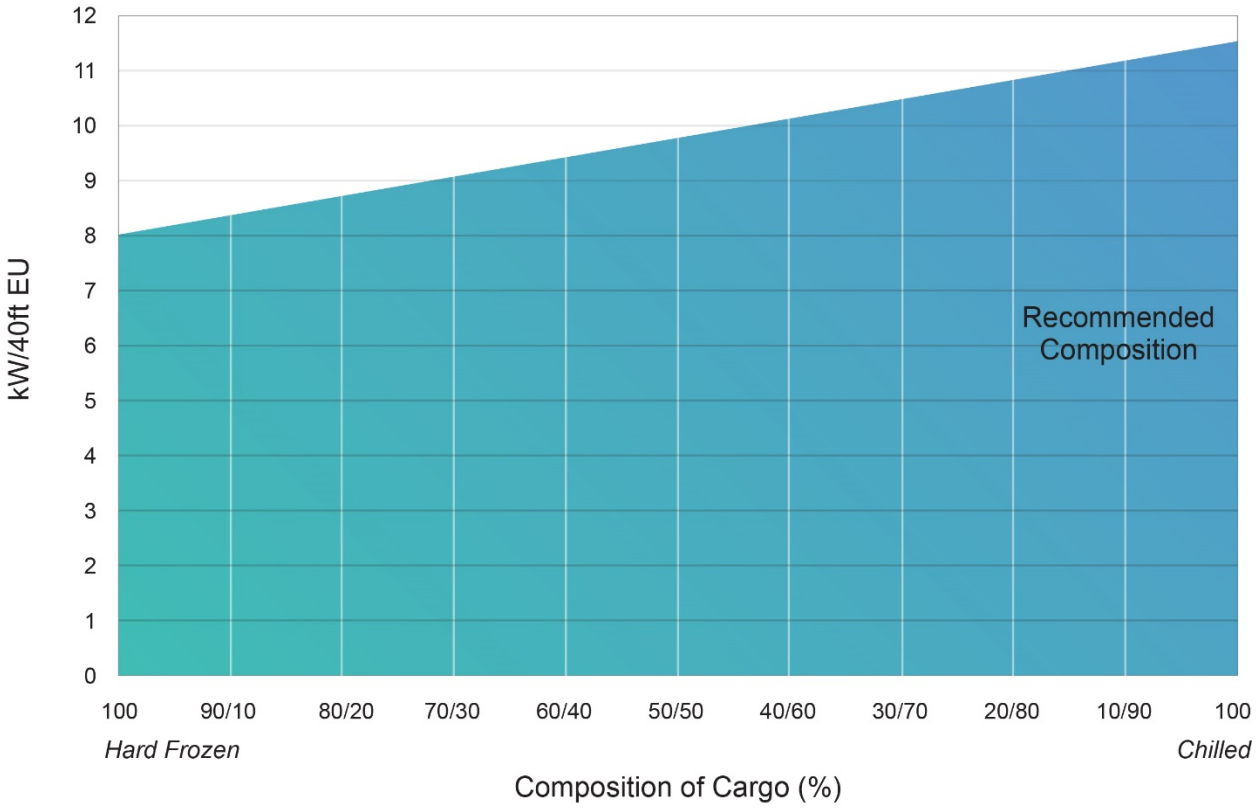

FIGURE 2
Electrical Demand for Ventilation System based on 20-Foot EU Containers

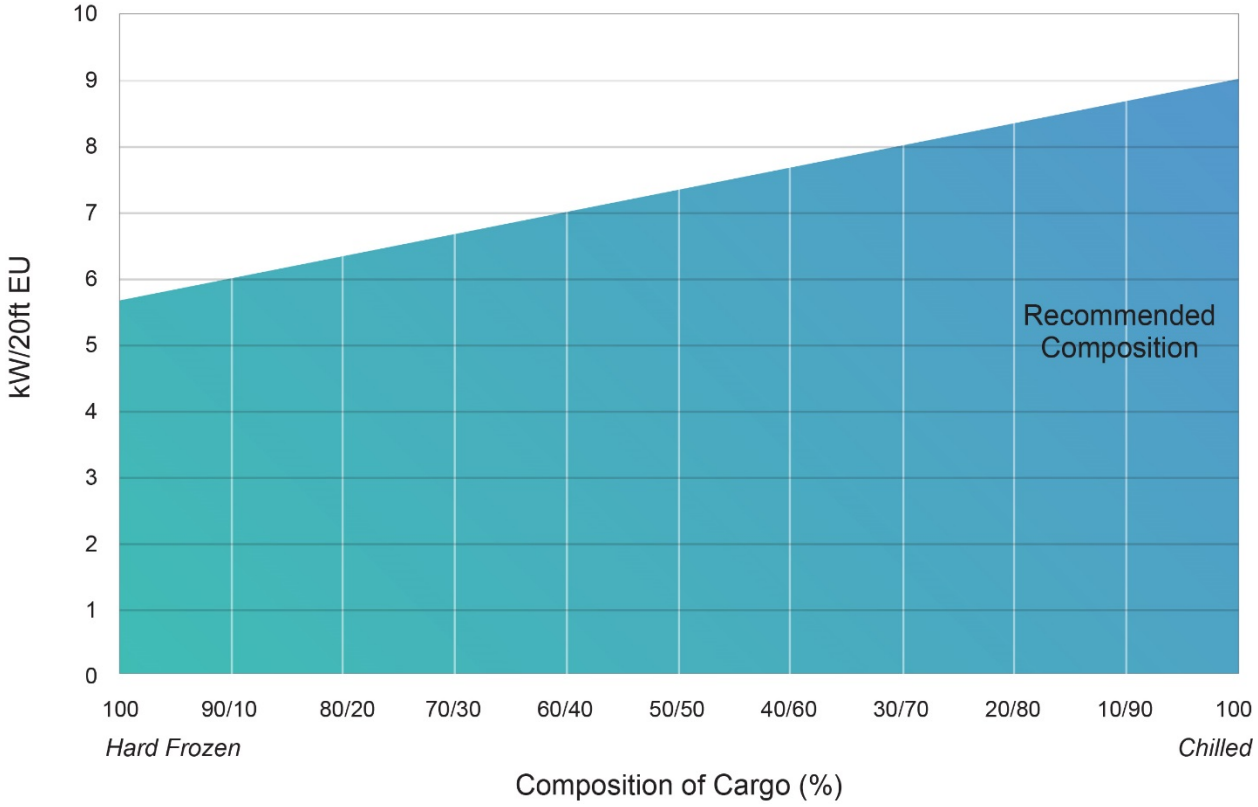

FIGURE 3
Electrical Demand for Generator and Power Distribution Systems based on 40-Foot EU Containers

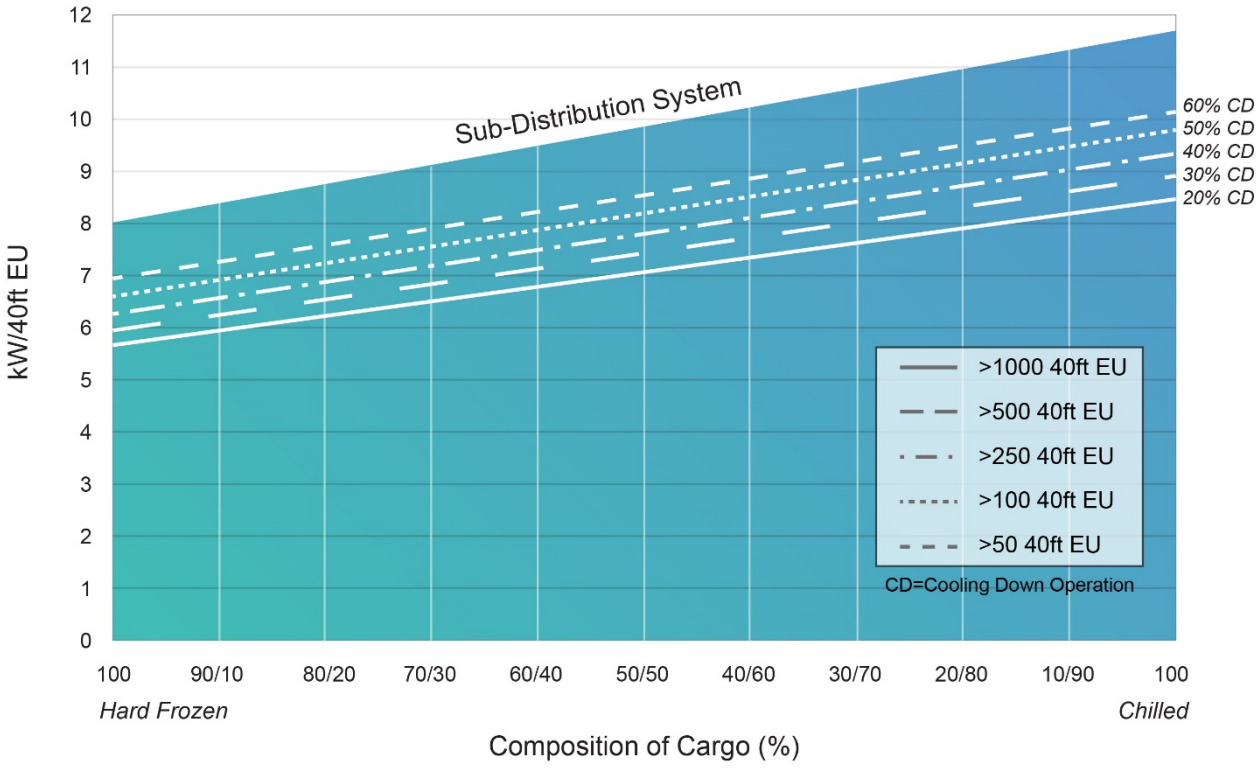

FIGURE 4
Electrical Demand for Generator and Power Distribution Systems based on 20-Foot EU Containers