[0004] The refrigeration units in presently known ULD containers are active temperature control devices that operate to adjust the temperature inside the ULD container to keep the internal temperature within a specified temperature range. The active temperature control devices are electrical cooling and heating systems that operate in response to internal temperature sensors to regulate the internal temperature. Such active temperature control devices in ULD containers may be expensive and require routine maintenance to manage the mechanical components. Failure of the mechanical components can cause nearly immediate temperature excursions and spoilage of the temperature-reliant cargo stored therein, which can be particularly problematic for life saving pharmaceutical products.

[0005] Passive temperature control solutions, on the other hand, are insulated boxes or containers without any active temperature control. Consequently, passive temperature control packaging does not have systems to make temperature adjustments in response to changes in the internal temperature of the container. Existing passive temperature-controlled packaging solutions are not ULD containers, and typically do not conform to the standard sizes designated for ULD containers. The non-ULD containers are typically loaded onto ULD pallets for consolidation with other packages. Labor is required for the secondary step of positioning the passive temperature-controlled non-ULD containers on the ULD pallets and covering the non-ULD containers with cargo nets. This often leaves open space that is not consumed by cargo but still incurs cargo fees. The nonconformity of the passive temperature-controlled packaging may require additional labor and handling for loading the cargo onto aircraft, which can reduce aircraft loading efficiencies and result in departure delays. Moreover, the non-uniform containers may not have the same tracking capability and customs clearances as the ULD containers, which can further increase processing times through the air freight supply chain.

Summary of the Disclosure

[0006] ~~In one~~ According to a first aspect of the present ~~disclosure~~ invention, there is provided a container suitable for use in a shipment of a cargo by air ~~is disclosed. ,~~ ~~T~~the container ~~may include~~ comprising: a container

body having a top wall, a bottom wall, a front wall, a rear wall and oppositely disposed side walls, wherein the container body defines a cargo space within the container, and a passive temperature control system located within the cargo space. The passive temperature control system ~~may include~~ comprising: a plurality of insulation panels, wherein each of the plurality of insulation panels is connected to an inner surface of a corresponding wall of the container body, wherein the plurality of insulation panels are exposed to the cargo space within the container, a rack having a top rack disposed proximate ~~one of~~ the top wall ~~and~~, a first side rack disposed proximate a first one of the oppositely disposed side walls, and a second side rack disposed proximate a second one of the oppositely disposed side walls, wherein the top rack ~~defining a slot~~, the first side rack and the second side rack are connected to each other to form a unitary structure that is inserted into the cargo space within the container, and wherein the top rack, the first side rack and the second side rack each define a plurality of slots, and a plurality of refrigerant bottles filled with a thermal medium~~.~~, wherein ~~T~~the plurality of refrigerant bottles and the thermal medium ~~may be~~ are one of cooled and heated to a predetermined temperature for the cargo being shipped in the container and inserted into the plurality of slots of the rack to passively maintain a cargo space temperature in the cargo space during the shipment of the cargo.

[0007] ~~In another~~ According to a second aspect of the present ~~disclosure~~ invention, there is provided a container suitable for use in a shipment of a cargo by air ~~is disclosed.~~, ~~T~~the container ~~may include~~ comprising a container body ~~and a passive temperature control system. The container body may have~~ having a top wall, a bottom wall, a front wall, a rear wall and oppositely disposed side walls, wherein the container body defines a cargo space within the container, and wherein the container body ~~may be~~ is fabricated as a structure that is a compliant unit load device (ULD) container meeting specified aviation authority structural requirements~~. The~~; and a passive temperature control system ~~is~~ located within the cargo space and ~~may have~~ having a plurality of insulation panels each connected to an inner surface of a corresponding wall of the container body wherein the plurality of insulation panels are exposed to the cargo space within the container, ~~at~~

~~least one~~ a rack having a top rack disposed proximate ~~a corresponding one of~~ the top wall ~~and the~~ , a first side rack disposed proximate a first one of the oppositely disposed side walls ~~of the container body~~, and a second side rack disposed proximate a second one of the oppositely disposed side walls, wherein the top rack, the first side rack and the second side rack are connected to each other to form a unitary structure that is inserted into the cargo space within the container, and a plurality of refrigerant bottles filled with a thermal medium and received by the ~~at least one~~ top rack, the first side rack and the second side rack to passively maintain a cargo space temperature in the cargo space during the shipment of the cargo.

[0008] ~~In a further~~ According to a third aspect of the present ~~disclosure~~ invention, there is provided a refrigerant bottle for a container suitable for use in a shipment of a cargo by air ~~is disclosed.~~ , wherein ~~T~~the container ~~may have~~ has an inner insulation layer and a rack proximate an insulation panel of the inner insulation layer and defining at least one slot~~.~~, ~~T~~the refrigerant bottle ~~may include~~ comprising: a reservoir body that is sized to be inserted into the at least one

slot of the rack~~,~~; and a connection mechanism defined in the reservoir body and configured to connect a plurality of refrigerant bottles in series for insertion and removal of multiple refrigerant bottles into and out of the at least on slot together~~.~~ wherein ~~T~~the refrigerant bottle ~~may be~~is one of cooled and heated to a predetermined temperature for the cargo being shipped in the container and inserted into the slot of the rack to passively maintain a cargo space temperature in a cargo space of the container during the shipment of the cargo, wherein the connection mechanism comprises: a bottle tab extending outward from a first end of the reservoir body; and a bottle socket defined in the reservoir body at a second end opposite the first end of the reservoir body, wherein the bottle tab and the bottle socket are configured to interlock when the bottle tab is slid into the bottle socket in a direction perpendicular to a plane of a side of the reservoir body so that a first adjacent refrigerant bottle may be connected to the first end of the reservoir body and a second adjacent refrigerant bottle may be connected to the second end of the reservoir body such that the refrigerant bottle, the first adjacent refrigerant bottle and the second adjacent refrigerant bottle move together into and out of the slot of the rack.

[0009] Additional ~~aspects~~ examples are defined by the claims of this patent.

Brief Description of the Drawings

[0010] Fig. 1 is an isometric view of a container meeting ULD specifications and having a passive temperature controlled packaging system in accordance with the present disclosure;

[0011] Fig. 2 is an isometric view of the container of Fig. 1 with a door removed;

[0012] Fig. 3 is an exploded isometric view of a base plate and a bottom insulation panel of the container of Fig. 1;

[0013] Fig. 4 is an exploded isometric view of the base plate of Fig. 3;

[0014] Fig. 5 is a front view of racks and refrigerant bottles of the container of Fig. 1;

[0015] Fig. 6 is an enlarged view of a portion of one of the racks and corresponding refrigerant bottles of Fig. 5;

[0016] Fig. 7 is an isometric view of a refrigerant bottle in accordance with the present disclosure;

[0017] Fig. 8 is an isometric view of two of the refrigerant bottles of Fig. 7 connected to each other;

[0018] Fig. 9 is an isometric view of a thermal break in accordance with the present disclosure; and

[0019] Fig. 10 is an exploded isometric view of a pallet, a bottom insulation panel and thermal breaks of the container of Fig. 1.

Claims

What is claimed is:

1. A container ~~(10)~~ suitable for use in a shipment of a cargo by air, the container ~~(10)~~ comprising:

a container body ~~(12, 14, 20)~~ having a top wall, a bottom wall ~~(12)~~, a front wall ~~(20)~~, a rear wall and oppositely disposed side walls, wherein the container body ~~(12, 14, 20)~~ defines a cargo space ~~(26)~~ within the container ~~(10);~~, and

a passive temperature control system ~~(16)~~ located within the cargo space ~~(26)~~, the passive temperature control system ~~(16)~~ comprising:

a plurality of insulation panels, wherein each of the plurality of insulation panels is connected to an inner surface of a corresponding wall of the container body, wherein the plurality of insulation panels are exposed to the cargo space within the container,

a rack ~~(42, 44)~~ having a top rack disposed proximate ~~one of~~ the top wall ~~and~~ , a first side rack disposed proximate a first one of the oppositely disposed side walls, and a second side rack disposed proximate a second one of the oppositely disposed side walls, wherein the top rack, the first side rack and the second side rack are connected to each other to form a unitary structure that is inserted into the cargo space within the container , and wherein the top rack ~~(42, 44)~~ , the first side rack and the second side rack each ~~defining~~ define a plurality of slots, and

a plurality of refrigerant bottles ~~(40)~~ filled with a thermal medium, wherein the plurality of refrigerant bottles ~~(40)~~ and the thermal medium are one of cooled and heated to a predetermined temperature for ~~a~~the cargo being shipped in the container ~~(10)~~ and inserted into the plurality of slots of the rack ~~(42, 44)~~ to passively maintain a cargo space temperature in the cargo space ~~(26)~~ during the shipment of the cargo.

2. The container ~~(10)~~ of claim 1, wherein the container body ~~(12, 14, 20)~~ is fabricated as a structure that is a compliant unit load device (ULD) container meeting specified aviation authority structural requirements.

3. The container ~~(10)~~ of claim 1, wherein the container body ~~(12, 14, 20)~~ comprises:

a pallet ~~(12)~~ forming the bottom wall;

an outer enclosure ~~(14)~~ forming the top wall, the rear wall and the oppositely disposed side walls, wherein the outer enclosure is mounted on the pallet ~~(12)~~; and

a door ~~(20)~~ forming the front wall, wherein the door is connected to one of the oppositely disposed side walls and rotatable between an open position and a closed position.

4. The container ~~(10)~~ of claim 1, comprising a telemetry system for transmitting data in real time to a remote processor.

5. The container ~~(10)~~ of claim 1, comprising a baseplate ~~(30)~~ having an upper metal sheet ~~(34)~~, a lower metal sheet ~~(36)~~ and an internal core ~~(38)~~ fabricated from a thermoplastic polymer and disposed between the upper metal sheet ~~(34)~~ and the lower metal sheet ~~(36)~~, wherein the baseplate ~~(30)~~ is disposed on top of a bottom insulation panel.

6. The container ~~(10)~~ of claim 5, wherein the thermoplastic polymer of the internal core ~~(38)~~ is high density polyethylene (HDPE).

7. The container ~~(10)~~ of claim 1, ~~wherein~~ comprising a bottom insulation panel ~~(32) has~~ disposed on top of the bottom wall and having a plurality of break holes ~~(88)~~ extending therethrough, the container ~~(10)~~ comprising a plurality of thermal breaks ~~(80)~~ having a thermal break height that is greater than a bottom insulation panel thickness, wherein each of the plurality of thermal breaks ~~(80)~~ is

disposed within a corresponding one of the plurality of break holes ~~(88)~~ such that each of the plurality of thermal breaks ~~(80)~~ engages ~~the~~ a top surface ~~(92)~~ of the bottom wall ~~(12)~~, and extends upward beyond an upper surface of the bottom insulation panel ~~(32)~~, and wherein the rack sits on top of the plurality of thermal breaks and is spaced above the upper surface of the bottom insulation panel so that the thermal breaks support~~s~~ a weight of the rack ~~(42, 44)~~ and the plurality of refrigerant bottles ~~(40)~~.

8. The container ~~(10)~~ of claim 7, comprising a baseplate ~~(30)~~ having an upper metal sheet ~~(34)~~, a lower metal sheet ~~(36)~~ and an internal core ~~(38)~~ fabricated from a thermoplastic polymer and disposed between the upper metal sheet ~~(34)~~ and the lower metal sheet ~~(36)~~, wherein the baseplate ~~(30)~~ is disposed on top of the bottom insulation panel, wherein the baseplate ~~(30)~~ has a plurality of break notches ~~(90)~~ defined therein with each of the plurality of break notches ~~(90)~~ having a position corresponding to one of the plurality of break holes ~~(88)~~ of the bottom insulation panel ~~(32)~~, and wherein each of the plurality of thermal breaks ~~(80)~~ extends upward beyond the upper surface of the baseplate ~~(30)~~.

9. The container ~~(10)~~ of claim 7, wherein each of the plurality of thermal breaks ~~(80)~~ comprises:

a break body ~~(82)~~;

a break foot ~~(84)~~ extending downward from the break body ~~(82)~~ and engaging the top surface ~~(92)~~ of the ~~pallet (12)~~ bottom wall when each of the plurality of thermal break~~s~~ ~~(80)~~ is disposed within a corresponding one of the plurality of break holes ~~(88)~~; and

a break shoulder ~~(86)~~ extending upward from the break body ~~(82)~~ and extending above the bottom insulation panel ~~(32)~~ and engaging the rack ~~(42, 44)~~ when each of the plurality of thermal break~~s~~ ~~(80)~~ is disposed within the corresponding one of the plurality of break holes ~~(88)~~.

~~10. The container (10) of claim 1, wherein the rack (42, 44) comprises: a top rack (42) disposed proximate the top wall;~~

~~a first side rack (44) disposed proximate a first one of the side walls; and a second side rack (44) disposed proximate a second one of the side walls.~~

~~11~~10. The container ~~(10)~~ of claim 1, wherein each of the top rack ~~(42, 44)~~, the first side rack and the second side rack comprises:

a plurality of parallel slats ~~(46)~~ disposed on either side of the rack ~~(42, 44)~~;

a plurality of ~~upper~~ first tracks ~~(48)~~ that are perpendicular to and connected to the plurality of parallel slats ~~(46)~~ and are oriented with ~~upper~~ first track channels opening ~~downward~~ in a first direction; and

a plurality of ~~lower~~ second tracks ~~(50)~~ that are perpendicular to and connected to the plurality of parallel slats ~~(46)~~ and are oriented with ~~lower~~ second track channels ~~facing upward~~ opening in a second direction, wherein the plurality of ~~upper~~ first tracks ~~(48)~~ and the plurality of ~~lower~~ second tracks ~~(50)~~ separate the plurality of parallel slats ~~(46)~~ on either side of the rack ~~(42, 44)~~ and are alternated so that each corresponding pair of ~~an upper~~ a first track ~~(48)~~ and a ~~lower~~ second track ~~(50)~~ and corresponding portions of the plurality of parallel slats ~~(46)~~ define one of the plurality of slots of the rack ~~(42, 44)~~.

~~12~~11. The container ~~(10)~~ of claim 1, wherein each of the plurality of insulation panels comprises:

a vacuum insulated panel (VIP); and

an outer covering of expanded polypropylene (EPP) foam.

~~13~~12. A container ~~(10)~~ suitable for use in a shipment of a cargo by air, the container ~~(10)~~ comprising:

a container body ~~(12, 14, 20)~~ having a top wall, a bottom wall ~~(12)~~, a front wall ~~(20)~~, a rear wall and oppositely disposed side walls, wherein the container body ~~(12, 14, 20)~~ defines a cargo space ~~(26)~~ within the container ~~(10)~~, and wherein the container body ~~(12, 14, 20)~~ is fabricated as a structure that is a compliant unit

load device (ULD) container meeting specified aviation authority structural requirements; and

a passive temperature control system ~~(16)~~ located within the cargo space ~~(26)~~ and having a plurality of insulation panels each connected to an inner surface of a corresponding wall of the container body ~~(12, 14, 20)~~wherein the plurality of insulation panels are exposed to the cargo space within the container, ~~at least one~~ a rack ~~(42, 44)~~ having a top rack disposed proximate ~~a corresponding one of~~ the top wall, a first side rack disposed proximate a first one of the oppositely disposed side walls, and a second side rack disposed proximate a second one of the oppositely disposed side walls, wherein the top rack, the first side rack and the second side rack are connected to each other to form a unitary structure that is inserted into the cargo space within ~~of~~ the container ~~body (12, 14, 20)~~, and a plurality of refrigerant bottles ~~(40)~~ filled with a thermal medium and received by the top rack ~~(42, 44)~~ , the first side rack and the second side rack to passively maintain a cargo space temperature in the cargo space ~~(26)~~ during the shipment of the cargo.

~~14~~13. The container ~~(10)~~ of claim ~~13~~12, wherein the container body ~~(12, 14, 20)~~ comprises:

a pallet ~~(12)~~ forming the bottom wall;

an outer enclosure ~~(14)~~ forming the top wall, the rear wall and the oppositely disposed side walls, wherein the outer enclosure is mounted on the pallet ~~(12)~~; and

a door ~~(20)~~ forming the front wall, wherein the door is connected to one of the oppositely disposed side walls and rotatable between an open position and a closed position.

~~15~~14. The container ~~(10)~~ of claim ~~13~~12, comprising a telemetry system for transmitting data in real time to a remote processor.

~~16~~15. A refrigerant bottle ~~(40)~~ for a container ~~(10)~~ suitable for use in a shipment of a cargo by air, wherein the container ~~(10)~~ has an inner insulation layer

~~(16)~~ and a rack ~~(42, 44)~~ proximate an insulation panel of the inner insulation layer ~~(16)~~ and defining at least one slot, the refrigerant bottle ~~(40)~~ comprising:

a reservoir body ~~(52)~~ that is sized to be inserted into the at least one slot of the rack ~~(42, 44)~~; and

a connection mechanism ~~(60, 62)~~ defined in the reservoir body ~~(52)~~ and configured to connect a plurality of refrigerant bottles ~~(40)~~ in series for insertion and removal of multiple refrigerant bottles ~~(40)~~ into and out of the at least on slot together, wherein the refrigerant bottle ~~(40)~~ is one of cooled and heated to a predetermined temperature for ~~a~~the cargo being shipped in the container ~~(10)~~ and inserted into the slot of the rack ~~(42, 44)~~ to passively maintain a cargo space temperature in a cargo space ~~(26)~~ of the container ~~(10)~~ during the shipment of the cargo~~.~~

~~17. The refrigerant bottle (40) of claim 16, wherein the refrigerant bottle (40) is filled with a thermal medium.~~

~~18. The refrigerant bottle (40) of claim 16~~, wherein the connection mechanism ~~(60, 62)~~ comprises:

a bottle tab ~~(60)~~ extending outward from a first end of the reservoir body ~~(52)~~; and

a bottle socket ~~(62)~~ defined in the reservoir body ~~(52)~~ at a second end opposite the first end of the reservoir body ~~(52)~~, wherein the bottle tab ~~(60)~~ and the bottle socket ~~(62)~~ are configured to interlock when the bottle tab is slid into the bottle socket in a direction perpendicular to a plane of a side of the reservoir body so that a first adjacent refrigerant bottle ~~(40)~~ may be connected to the first end of the reservoir body ~~(52)~~ and a second adjacent refrigerant bottle ~~(40)~~ may be connected to the second end of the reservoir body ~~(52)~~ such that the refrigerant bottle ~~(40)~~, the first adjacent refrigerant bottle ~~(40)~~ and the second adjacent refrigerant bottle ~~(40)~~ move together into and out of the slot of the rack ~~(42, 44)~~.

16. The refrigerant bottle of claim 15, wherein the refrigerant bottle is filled with a thermal medium.

~~19~~17. The refrigerant bottle ~~(40)~~ of claim ~~16~~15, wherein the reservoir body ~~(52)~~ has a handle ~~(64)~~ defined therein.

~~20~~18. The refrigerant bottle ~~(40)~~ of claim ~~16~~15, the at least one slot of the rack ~~(42, 44)~~ is defined by an upper track ~~(48)~~ that is oriented with an upper track channel opening facing downward and a lower track ~~(50)~~ that is oriented with lower track channel facing upward, wherein the refrigerant bottle ~~(40)~~ comprises:

an upper shoulder ~~(56)~~ extending upward from an upper edge of the reservoir body ~~(52)~~; and

a~~n~~ lower shoulder ~~(58)~~ extending downward from a lower edge of the reservoir body ~~(52)~~, wherein the upper shoulder ~~(56)~~ is received into the upper track channel of the upper track ~~(48)~~ and the lower shoulder ~~(58)~~ is received into the lower track channel of the lower track ~~(50)~~ when the refrigerant bottle ~~(40)~~ is inserted into the at least one slot of the rack ~~(42, 44)~~ to guide the refrigerant bottle ~~(40)~~ within the at least one slot.

19. The container of claim 1, comprising a bottom insulation panel disposed on top of the bottom wall and having a plurality of break holes extending therethrough, the container comprising a plurality of thermal breaks having a thermal break height that is greater than a bottom insulation panel thickness, wherein each of the plurality of thermal breaks is disposed within a corresponding one of the plurality of break holes such that each of the plurality of thermal breaks engages a top surface of the bottom wall and extends upward beyond an upper surface of the bottom insulation panel, and wherein the first side rack and the second side rack sit on top of the plurality of thermal breaks and are spaced above the upper surface of the bottom insulation panel so that the thermal breaks support a weight of the rack and the plurality of refrigerant bottles.