CLAIMS

1. A composite tank apparatus for fluid containment at pressures at or near ambient to 1moderate pressures comprising:

a) an array of at least two flat-sided co-dependent cells with relatively thin skin cell walls made of metallic or non-metallic materials, each of the at least two flat-sided co-dependent cells having at least two flat wall panel portions connected by radiused sections arranged such that all of the flat wall panel portions of the at least two flat-sided co-dependent cells are either in flush contact with each other or in flush contact with flat supporting panels of an enclosing structure (or thermal insulating material lining interior flat surfaces of the enclosing structure) enclosing the array of at least two flat-sided co-dependent cells, each of the at least two flat-sided co-dependent cells having a top and a bottom cap connected respectively to top and bottom ends of the at least two flat wall panel portions comprising flat walls joined by the radiused sections;

b) the at least two flat-sided co-dependent cells sealed with each other around a perimeter of at least one matching pair of lightening through-wall holes provided in adjacent pairs of the flush-contacting flat wall panel portions of the at least two flat-sided co-dependent cells in the composite tank, the perimeter of all the pairs of lightening through-wall holes sufficiently sealed to structurally resist relative movement and prevent leakage of fluid from containment;

c) the enclosing structure having an interior surface and an exterior surface, the enclosing structure configured to provide environmental isolation with sufficient structural strength and with sufficient rigidity to support exterior flat side panel portions of the at least two flat-sided co-dependent cells at exterior portions of the array of at least two flat-sided co-dependent cells such that, when internal pressure is established within the array of at least two flat-sided co-dependent cells at a targeted level for operations or survival, the at least two flat-sided co-dependent cells of the array are prevented from over-expanding and displacing; and

d) optionally, one or more layers of thermally insulating material lining the interior surface or the exterior surface of the enclosing structure.

2. The composite tank apparatus of claim 1 wherein the cell walls are selected from steel alloys or aluminum alloys, the cell walls having thickness ranging 25.4mm to 76.2mm.

3. The composite tank apparatus of claim 1 wherein the cell walls are selected from fiber-impregnated artificial rubber sheet, fiber-resin matrix, or ferro-cement materials.

4. The composite tank apparatus of claim 1 wherein the perimeter of all the pairs of lightening through-holes are sealed by a continuous weldment joining the adjacent pairs of the flush-contacting flat wall panel portions.

5. The composite tank apparatus of claim 1 wherein the at least two flat-sided co-dependent cells of the array are configured to be prevented from expanding and displacing beyond limits that would induce horizontal and vertical stresses exceeding 95% of allowable horizontal and vertical stress values under operating pressure.

6. The composite tank apparatus of claim 1 wherein the at least two flat-sided co-dependent cells of the array are configured to be prevented from expanding and displacing beyond limits that would induce horizontal and vertical stresses exceeding 99% of allowable horizontal and vertical stress values under operating pressure.

7. The composite tank apparatus of claim 1 configured for storage of fluids that must be contained at temperatures at least 10ºC different from normal ambient conditions.

8. The composite tank apparatus of claim 1 configured to receive and store fluid at temperatures below minus 40ºC, the enclosing structure comprised of non-cryogenic (mild or low alloy) steel, and one or more layers of thermally insulating material sufficient to establish a barrier to protect the steel from risk of brittle failure.

9. The composite tank apparatus of claim 1 comprising, openings, or conduits for injection and withdrawal of fluids.

10. The composite tank apparatus of claim 9 wherein fluid accessways comprise at least two conduits, wherein one or more conduits penetrate into the top or bottom caps of one or more of the at least two flat-sided co-dependent cells of the composite tank apparatus to join with conduits that run horizontally within co-dependent cells and through adjacent interior walls of the array of the at least two flat-sided co-dependent cells allowing simultaneous injection and ejection of fluids.

11. The composite tank apparatus of claim 1 comprising one or more top-mounted accessway fittings to allow humans or non-human devices to gain access to interiors of all of the at least two flat-sided co-dependent cells for their inspection, monitoring, and/or repair.

12. The composite tank apparatus of claim 1 comprising one or more top cap-mounted accessway fittings comprising pressure-competent fluid conduits through the top cap of one or more of the at least two flat-sided co-dependent cells for the purpose of injecting fluids into or withdrawing fluids from the composite tank apparatus.

13. The composite tank apparatus of claim 1 comprising one or more bottom cap-mounted accessway fittings comprising pressure-competent fluid conduits through the bottom cap of one or more of the at least two flat-sided co-dependent cells for the purpose of injecting fluids into or withdrawing fluids from the composite tank apparatus.

14. The composite tank apparatus of claim 1 comprising at least one internally interconnecting manifold extending into all of the at least two flat-sided co-dependent cells of the composite tank apparatus through the lightening through-wall holes across adjacent walls of the co-dependent cells comprising the composite tank apparatus.

15. A method of making a substantially metallic composite tank system:

a) providing a plurality of thin metallic flat wall panel portions, a plurality of metallic radiused sections, and a plurality of metallic top and bottom caps to produce at least two flat-sided co-dependent cells with relatively thin skins;

b) optionally providing one or more accessways where and as needed in the plurality of thin metallic flat wall panel portions;

c) optionally providing one or more penetrations where and as needed in the plurality of metallic top and bottom caps;

d) fastening the flat panel portions to tangent edges of the plurality of radiused sections to form a plurality of cell bodies, and fastening the plurality of metallic top and bottom caps (with their tangent edges) to the plurality of cell bodies to form the at least two flat-sided co-dependent cells with relatively thin skins;

e) arranging the at least two flat-sided co-dependent cells with relatively thin skins such that all of the flat wall panel portions of the at least two flat-sided co-dependent cells are

either in flush contact with each other or in flush contact with flat supporting panels of an enclosing structure (or thermal insulating material lining an interior of the enclosing structure) to form an enclosed array of at least two flat-sided co-dependent cells;

f) sealing the at least two flat-sided co-dependent cells with each other around a perimeter of at least one matching pair of lightening through-wall holes provided in adjacent pairs of the flush-contacting flat wall panel portions of the at least two flat-sided co-dependent cells in the composite tank, the perimeter of all the matching pairs of lightening through-wall holes sufficiently sealed to structurally resist relative movement and prevent leakage of fluid from containment; and

g) the enclosing structure having an interior surface and an exterior surface, , the enclosing structure configured to provide environmental isolation with sufficient structural strength and with sufficient rigidity to support exterior flat side panel portions of the at least two flat-sided co-dependent cells at exterior portions of the array of at least two flat-sided co-dependent cells such that, when internal pressure is established within the array of at least two flat-sided co-dependent cells at a targeted level for operations or survival, the at least two flat-sided co-dependent cells of the array are prevented from expanding and displacing to such a degree that the resulting stresses exceed relevant pressure vessel code allowables or structural instability occurs.

16. A method of flowing a fluid into and extracting a same or different fluid from tops and bottoms of an array of at least two flat-sided cells of a composite tank apparatus for fluid containment, the composite tank apparatus having through-wall lightening holes in adjacent flat wall panel portions of all adjacent cells of the array of at least two flat-sided cells, the cells each having a top cap and a bottom cap, the method comprising:

(a) providing upper and lower horizontal fluid conducting manifolds that extend internally through the through lightening holes in adjacent flat wall panel portions of all adjacent cells of the array of at least two flat-sided cells of the composite tank apparatus;

(b) providing a first plurality of risers fluidly connected to and running from the upper horizontal fluid conducting manifold to near a top of each cell' s top cap in the array of cells of the tank apparatus providing a flow path from the top of each cell into the upper horizontal fluid conducting manifold;

(c) providing a second plurality of risers fluidly connected to and running from the lower horizontal fluid conducting manifold to near a bottom of each cell' s bottom cap in the

array of cells of the composite tank apparatus providing a flow path from the bottom of each cell into the lower horizontal fluid conducting manifold;

(d) providing at least one third riser fluidly connected to and running from the upper horizontal fluid conducting manifold to and through an accessway fitting on the top cap or bottom cap of at least one of the cells in the array of cells of the composite tank apparatus;

(e) providing at least one fourth riser fluidly connected to and running from the lower horizontal fluid conducting manifiold to and through an accessway fitting on the top cap or bottom cap of at least one of the cells in the array of cells of the composite tank apparatus; and

(f) flowing a low density fluid of a first specified pressure and a first temperature into or out of an upper part of the composite tank apparatus of the first aspect through the at least one third riser of while flowing a higher density fluid of the same or different chemical composition and of a second specified pressure and a second temperature simultaneously into or out of the bottom of the cells in the array of cells of the composite tank apparatus of the first aspect through the at least one fourth riser in a manner that allows a targeted pressure and temperature regime to be maintained within the composite tank apparatus.

17. The composite tank apparatus of claim 1 wherein the composite tank a.pparatus is contructed as a part of a facility selected from:

a) a storage facility fixed permanently or temporarily in place on land,

b) a transportable ISO container;

c) a trailer for over-road transport;

d) a rail cargo car or rail fuel tender for rail transport;

e) a cargo or fuel containment within or on a barge or ship.

18. The method of claim 16 wherein the composite tank apparatus is used to store fluids selected from LNG, NGL, NH_3, CO_2, and H_2 as a dense gas, a liquid, or captured in a slurry of molecules (e.g., magnesium hydride suspended in mineral oil, such as the material known under the trade designation Hydrilyte™).

19. The method of claim 16 wherein the composite tank apparatus is used to transport fluids selected from LNG, NGL, NH_3, CO_2, and H_2 as a dense gas, a liquid, or captured in a slurry of molecules (e.g., magnesium hydride suspended in mineral oil as Hydrilyte™.

20. The method of claim 15 comprising structurally combining all cells in the cellular array to establish a primary containment of the composite tank apparatus, wherein matching through-wall holes are opened in adjacent, flush-contacting flat wall panel portions and their aligned perimeters are welded or clamped together in a way that structurally resists relative movement and prevents leakage of fluid from containment.

21. The method of claim 15 comprising fluidly linking all cells in an integrated cellular array comprising a primary containment of the composite tank apparatus to establish internal flow paths from within the bottom caps and top caps and through the flat wall panel portions of the cells of the composite tank apparatus with lower and upper manifolds connecting uptake riser and downcomer riser pipe sections from near the lowest internal point of each cell's bottom and the highest internal point of each cell's top wherein these lower and upper manifolds include riser elements that tightly penetrate the skin of at least one cell of the composite tank to enable the injection to and extraction from the composite tank's primary containment.

22. The method of Claim 21 for fluidly linking all cells in the cellular array comprising the primary containment of the composite tank apparatus to establish internal flow paths from all portions of the composite tank apparatus wherein manifolded flow paths include branches reaching near enough to all lower and upper extremes of an internal volume of the primary containment to effectively fill and drain the primary containment of fluids.

23. The method of claims 21 for fluidly linking all cells in the cellular array comprising the primary containment of the composite tank apparatus to establish internal flow paths from all portions of the composite tank apparatus wherein the composite tank apparatus' orientation is biased with a transverse inclination such that the bottom caps of all its cells each have a definitive low point at or near the intake of a riser attached to a lower piping manifold or one of its branches to effectively fill and drain the tank of liquid or dense phase fluids and a definitive high point at or near the intake of a riser attached to an upper manifold or one of its branches to effectively fill and purge the tank of lighter dense phase or gaseous fluids.