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(54) **LNG storage tank**

(57) Disclosed is a concrete tank for very large LNG tanks. The invention utilizes membrane technology in concrete structures that deviate from the standard cylindrical constructions. Typical concrete housings of the invention are a parallelepipedic structure, or an annular structure comprising two concentric walls. Both struc-

tures can be covered by a gabled or an arched roof, and avoid the size limitations imposed on cylindrical structures as a result of the size limitations inherent to concrete domes. The invention proposes also several ways to improve the available working height of LNG within such concrete structures of a given height.

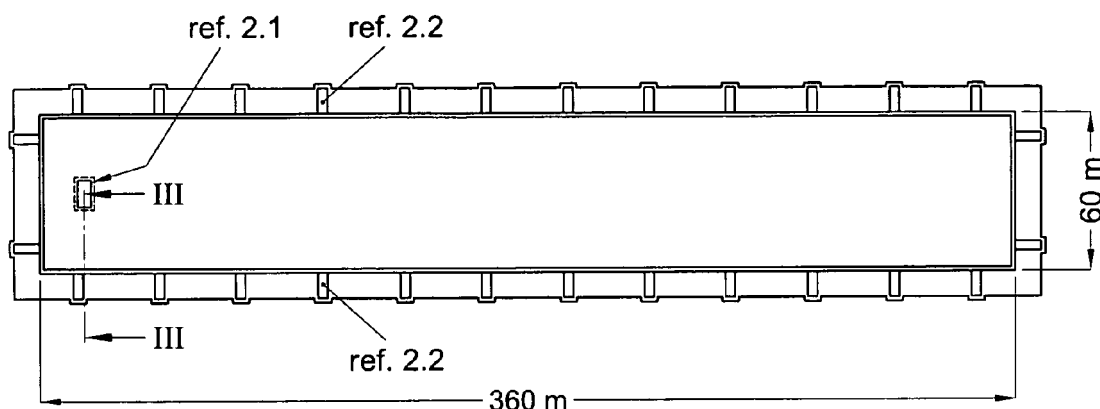


Fig. 2

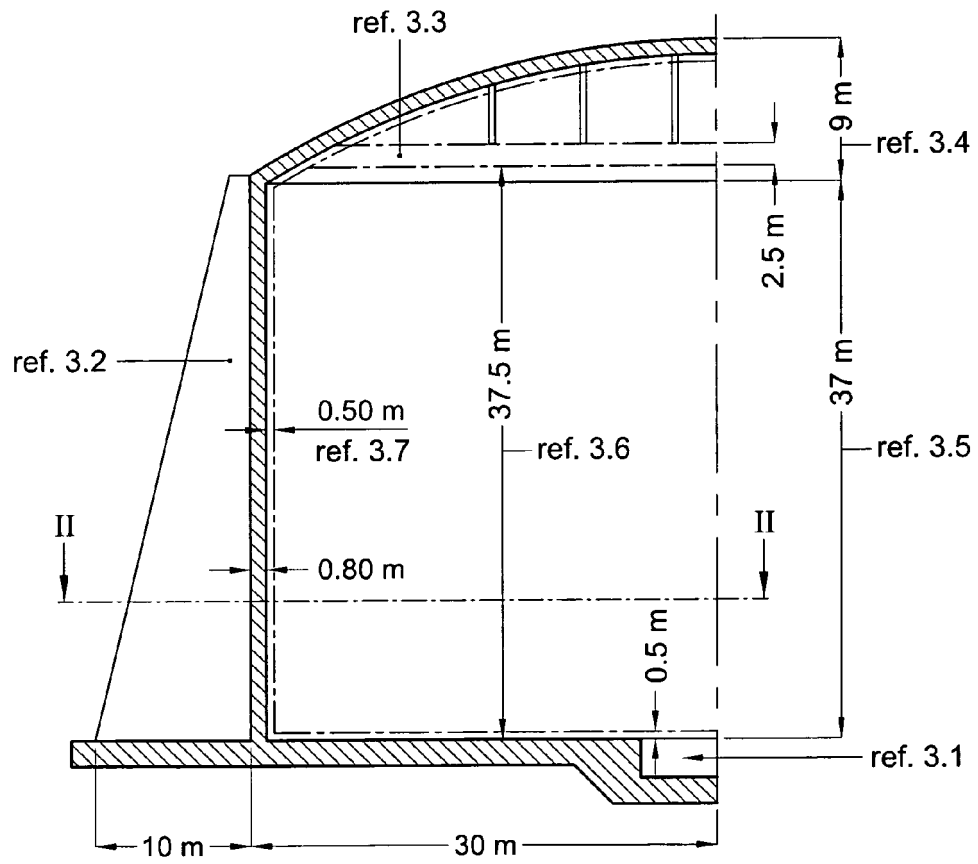


Fig. 3

Description

Field of the invention

[0001] The invention is in the field of the storage of natural gas. Particularly, the invention pertains to ultra-large storage tanks for liquefied natural gas (LNG). Further, the invention pertains to the use of concrete structures for the storage of LNG and to the use of an LNG Insulating Membrane as a lining in an on-shore concrete LNG storage tank.

Background of the invention

[0002] Natural gas can generally be stored in two forms, either as a gas reinjected under pressure in geological underground structures, or in a liquefied (LNG) form, typically refrigerated at about -160°C at near atmospheric pressure in cylindrical insulated tanks.

[0003] Geological structures could be aquifer layers, depleted oil or gas fields, and salt caverns created by dissolution in salt domes or salt lays. In general, LNG storage is considered to be more costly than underground storage. Its use is currently limited to specific situations, for which underground storage is not an option. E.g. the operational storage at LNG receiving terminals, to store the unloading LNG ship capacity, plus a shipping margin for a few days of send-out, or for peak storage facilities to be built near large gas consuming areas, to offset a short period of peak consumption.

[0004] Such LNG storage facilities are based on one or a few LNG tanks of unit capacities up to $200,000\text{ m}^3$. Also larger LNG storage facilities comprising a larger number of tanks (e.g. 7 to 10 tanks of nominal capacities of $180,000$ to $200,000\text{ m}^3$ are existing in Japan and Korea where no adequate underground structure are available to solve consumption variations. It would be desired to provide larger tanks, so as to achieve a higher storage capacity, or a similar capacity on the basis of a lower number of tanks.

[0005] Underground storages, especially aquifer and depleted fields, are mostly dedicated to solve the seasonal or strategic storage requiring much larger capacities. The salt cavern storages have more reduced capacities but still higher than current typical LNG storage. They are playing an intermediate function, as they are able, like also LNG storage, to deliver high flow rates within short notice.

[0006] The cost comparison between the LNG storage in tanks and in a salt cavern is generally in favor of the salt cavern, as soon a convenient structure is found not too far from the network. However, the development of such storages raises sometimes difficulties, notably among them the disposal of the salt saturated water produced during the cavern dissolution stage. Also, it requires many years for geological exploration and investigations, permits, and preparation of a salt cavern by salt dissolution.

[0007] It would thus be desired to provide an LNG storage that leads to a more favorable cost comparison with salt cavern underground storage..

[0008] For LNG storage, two technologies are currently used. One is a self-containment technology in which the LNG is contained in a cylindrical vessel made of cryogenic metallic plates (mostly 9% nickel steel), which is capable of sustaining the hydrostatic pressure of the liquid, and which is externally insulated. The metallic vessel is, in most cases, included in an external prestressed concrete envelop which gives a secondary barrier. The size of such technology is limited, on account of structural limitations imposed by the use of concrete (for which the cover, i.e. a concrete dome is limiting), as well as by weldability issues on account of the thickness of 9% Ni Steel plates.

[0009] The other is a so-called "membrane technology".

[0010] Herein the external concrete shell bottom and walls are covered by a multilayer structure typically comprising a stainless steel lining (this is also sometimes referred to as the membrane, while also the term 'membrane technology' is used to denote the entire multilayer structure), several insulation layers and optionally another metal containment layer.

[0011] In the field of LNG storage, the term "membrane technology" is generally recognized as denoting a structure incorporating three functions:

1. Tightness against LNG;
2. Insulation;
3. Load-transferring capacity;

[0012] In on-shore tanks, the latter results in load-transfer to a concrete shell. The insulation is provided by a flexible membrane capable of bearing thermal contraction at -160° . Cold insulation is provided, between membrane and the internal surface of the concrete structure, by typically rigid insulation panels able to transmit the hydrostatic LNG pressure to the external structure,

[0013] The membrane technology is largely used for the LNG ship carriers, where its adaptability to the ship's hull compartment shape allows a better hull space utilization than a containment system on the basis of self supporting spheres.

[0014] It has also been used for on-shore cylindrical tanks, but on this type of cylindrical tanks the self supporting technology remains dominant, except for the use in in-ground tanks built in Japan.

[0015] But whatever type of technology, self supporting or membrane, is used, one other size limitation for such cylindrical tanks is currently given by the diameter of the external concrete shell covering dome diameter, for which about 90 m is presently considered as a reasonable economical limit, leading to a unit tank size of about $200,000\text{ m}^3$ of LNG.

[0016] If this kind of tank size is convenient for moderate global capacities required most LNG receiving ter-

minals, larger capacities equivalent to the one considered for salt cavern storages, would require a large number of for instance 200,000 m³ tanks. As a consequence, the number of internal equipments, space, and connecting networks is multiplied by the number of tanks required, which results in an undue increase in the costs associated with this type of storage, extending beyond the costs associated with salt cavern storage.

[0017] It would be desired to limit the number and cost of full containment LNG tanks to obtain such large storage capacity in LNG form, at a competitive cost with salt cavern, by having larger individual tanks, e.g. of a size above 300,000 m³.

[0018] Also it is desired to increase the working height of the LNG containment system available within a given height of the external concrete shell by suppressing or reducing the height loss due to minimum suction level of the in-tank pumps, or the safety margin at the top between the insulated wall height and the maximum operational level of the LNG.

Summary of the invention

[0019] In order to better address one or more of the foregoing desires, the invention presents, in one aspect, a storage tank for liquefied natural gas (LNG) comprising a prestressed concrete shell and a membrane type internal containment system wherein the concrete shell comprises a concrete slab substantially parallel to a ground surface, at least two concrete walls extending vertically from said slab, said walls defining an open space, wherein the open space is covered by a concrete roof, and wherein the floor, the walls, and the roof together form a closed compartment.

[0020] In another aspect, the invention provides the use of a membrane-type LNG containment as a lining in an on-shore concrete LNG storage tank, wherein the concrete comprises a structure comprising a concrete floor substantially parallel to a ground surface, at least two concrete walls extending vertically from said floor, said walls defining an open space, wherein the open space is covered by a concrete roof, and wherein the floor, the walls, and the roof together form a closed compartment.

[0021] In a still further aspect, the invention pertains to the use of a concrete structure comprising a concrete floor substantially parallel to a ground surface, at least two concrete walls extending vertically from said floor, said walls defining an open space, wherein the open space is covered by a concrete roof, and wherein the floor, the walls, and the roof together form a closed compartment, and wherein the concrete structure comprises a lining in accordance with membrane technology, for the storage of LNG.

Brief description of the drawings

[0022] Fig. 1 presents a schematic drawing of an on-shore LNG storage tank as used in the art;

[0023] Figs. 2-3 represent schematic drawings of one embodiment of the invention, in the form of a parallelepipedic design (PLP type); Fig. 2 is a ground plan;

[0024] Fig. 3 is a cross-section of part of the tank.

[0025] Figs. 4-6 represent schematic drawings of one embodiment of the invention (annular design) (ANL type); Fig. 4 is a ground plan; Fig. 5 is a cross-section of part of the concrete structure; Fig. 6 is a cross section over the diameter of the annular tank.

[0026] Fig. 7 a-c depict some exemplary ground plans of LNG storage tanks of the invention.

Detailed description of the invention

[0027] In a broad sense, the invention is based on the judicious recognition that other shapes of concrete external shell than the traditional cylindrical design, will enable building much larger LNG storage tanks than assumed thus far. Thus, in accordance with the invention a concrete structure is provided of a very large volume (e.g. above 300,000 m³), while still allowing to be covered with a roof of limited span.

[0028] This recognition can be put to use on the basis of the so-called "membrane technology" for providing an LNG-tight lining in such a concrete shell, thus avoiding the size limitations given by the self supporting 9 % Ni internal shell technology.

[0029] As a minimum requirement, the concrete housing of the invention is provided with any kind of liquid and gas-tight lining that is not subject to size or shape limitations due to thermal dilatation effects or hydrostatic load and which has or will be certified to be used for LNG storage.

[0030] Without wishing to exclude future type linings, such a lining nowadays is preferably in the form of the above-mentioned "membrane technology." This refers to a membrane-type internal containment system that generally comprises a laminate of a plurality of barrier layers and insulating layers. Generally one or more layers of a barrier material are put on the LNG- containment side and within the insulating layers. The insulating layers generally comprise a multilayer structure, e.g. a laminate comprising stainless steel, and one or more insulating layers, generally in the form of panels.

[0031] Several types of "membrane technology" have been developed, using different types of membrane or insulation types, and using also different secondary barrier inside the membrane insulation sandwich.

[0032] One of the most preferred forms of membrane technology is a system disclosed by GTT in, *inter alia*, US 2005 / 0082297 A1, which uses one corrugated stainless steel membrane, insulation provided by rigid polyurethane foam included in plywood forming load bearing panels, and a secondary barrier made of triplex, a membrane made of aluminum sheet inserted in two layers of woven fiber glass.

[0033] In the invention a judicious use is made of the advantages of a "membrane technology" system. Ac-

cordingly:

- Membrane systems can be adapted to any external shape of structure provided this external structure is able to support the hydrostatic load, and its surface allows placing the systems, which are usually in the form of multilayer (preferably sandwich) panels;
- Membrane systems have no size limitation as the thermal contraction is borne locally by the membrane corrugation (stainless steel membrane) or the type of alloy (invar). This is an advantage as compared to self-supporting vessels, which require a solution for differential thermal displacements in their design;
- The membrane multilayer specification is not limited by size and the hydrostatic pressure; this is contrary to the typical self supporting 9 % Ni vessel, for which thickness and cost are dependent on diameter and hydrostatic load. The latter limits, for weldability concerns, the possible size of such self supporting cryogenic vessels presently to about 200.000 m³.

[0034] Materials for providing the lining are known in the art. One type of material as disclosed by GTT (Gaz-transport & Technigaz) comprises a laminate having two barrier layers. Viewed from the inside (the LNG- containment side) to the outside, these are:

- a corrugated stainless steel membrane as a primary barrier layer;
- plywood
- polyurethane foam
- a secondary barrier
- polyurethane foam
- plywood.

[0035] The set of layers other than the stainless steel membrane are together referred to as an insulating panel. The insulating panel is anchored to a concrete wall, by anchoring elements such as mastic and studs. The secondary barrier is e.g. a composite material comprising an aluminum sheet inserted between two layers of woven fiber glass.

[0036] LNG Insulating Membrane generally refers to a multilayer structure comprising a metal layer that is to form the inside (i.e. the LNG containment side) of a storage tank, an insulating layer placed on the outside (i.e. facing in the opposite direction from the LNG containment) of the metal layer, and a second metal or composite layer placed on the outside of or within the insulating layer, thus forming a laminate of several consecutive layers: metal - plywood - insulation - secondary barrier - insulation - plywood - . Other configurations than this sandwich multilayer including different orders of layers and larger numbers of layers, are conceivable.

[0037] It is to be noted that the multilayer structure in an LNG membrane generally refers to layers that are connected, but which are capable of movement relative to each other.

[0038] In a further example of membrane technology, also from GTT, a preferred LNG Insulating Membrane comprises primary and secondary membranes both made from Invar (a 36% nickel-steel alloy).

[0039] As noted above, the "LNG Membrane Technologies" are mostly used in ships. Whilst recently some suggestions have been made in the field as to the use of GTT membrane technology (or, for that matter, other membrane technology) for on-shore LNG storage tanks, this does not change the concept of the concrete housing from those of existing on-shore tanks.

[0040] The invention provides an at least bifold recognition. On the one hand, that LNG Insulating Membranes do not bring about limitations as to size. Thus, this technology can be used in accordance with the invention to provide LNG storage tanks, on shore, of larger size than have existed. On the other hand, the invention provides the acknowledgement that the size limitations of cupola structures in concrete can be avoided for LNG storage tanks.

[0041] With the size and shape limitations avoided, by virtue of the use of membrane technology, the invention provides a shape for the concrete housing that is, in its simplest form, a floor representing a rectangular plane, provided with four walls, each defining a side of said plane, and a roof covering said walls.

[0042] The volume of the structure is given by the mere heights and lengths of the walls. The walls generally are two long walls extending preferably substantially parallel to each other (longitudinal walls) and two walls connecting at either end the two longitudinal walls with each other, i.e. transversal walls. This design is referred to as a parallelepiped (PLP) tank.

[0043] In this embodiment, the ability to construct a roof of limited span, is given by the limited span provided by the limited width of this parallelepipedic form to which the non limited length will give the required volume. The hydrostatic load applied to the vertical walls is taken by way of prestressing and by regularly spaced reinforcement buttresses.

[0044] Whilst, from a construction point of view, this represents a simple type of building, it has not occurred in the art to use the volume available in this type of structure for an LNG-tight structure, for the purpose of storage of LNG.

[0045] It will be understood that many deviations from the structure of the invention are possible. E.g., the longitudinal walls need not be parallel to each other. In that case the transversal walls will simply have different lengths. The walls can extend perpendicular to the floor, but it is also conceivable that one or more of the walls are tilted, i.e. making an angle different from 90° with the floor.

[0046] It will also be understood that the LNG storage tank of the invention can have a number of walls different from four. E.g., an angular structure can be built having more than four walls. E.g. in which the ground plane has an L-shape, an H-shape, a U-shape, or any other shape

in which a three-dimensional volume can be realized in concrete, without the limitations associated with a concrete roof that needs to span a cylinder as is currently done in the art.

[0047] Further, it should be understood that the at least two walls can refer to a single wall in which, other than in the case of a cylindrical structure, at least two different segments of the wall can be distinguished. Such different segments can, e.g. be, two substantially parallel segments, or they can be the different segments (longitudinal and transversal) recognized in an ellipse. Thus, the at least two walls can be in the form of segments of a single wall having a semi-circular or elliptical shape.

[0048] In a preferred embodiment, the walls are concentric vis-à-vis each other, and more preferably annular. I.e., here only two walls are required. It is conceivable to extend the concentric design with one or more further walls, i.e. viewed from the top these represent a plurality of concentric circles.

[0049] The LNG storage tank of the invention can be placed above ground, but can also be realized with an embankment, or semi-buried. For buried or semi-buried tanks, the annular design is preferred, as this shape will be better capable of bearing the soil pressure.

[0050] The material in which the concrete housing is built, is prestressed concrete. It is well-known to the skilled person in building LNG storage tanks how to provide concrete suitable for building LNG storage tanks, and how to build the tanks. The designs according to the invention represent shapes that a skilled person can easily build in prestressed concrete.

[0051] To the extent that the LNG storage tank of the invention comprises a closed compartment, it will be understood that this refers to a compartment capable of containment of LNG. This does not exclude the presence of any valves, doors, or other facilities that may result in the closed compartment to be opened.

[0052] The roof can have any shape, e.g. a flat roof, a gabled roof, a hip roof, an arched roof, which are all shapes that by mere lengthening of the longitudinal dimension of the housing can support a larger volume than a domical roof (i.e. a cupola).

[0053] By way of example only reference is made to the following possible structures according to the invention:

- a PLP tank: 60 meters wide and with a length 360 meters,
- an annular form, ANL tank, with external diameter, for instance of 180 m, but with an internal cylindrical wall of, for instance, 60 m diameter which then supports the dome of 60 m span.

[0054] Both of these examples can be built with a height similar to that of conventional storage tanks, which is typically 30 to 50 meters.

[0055] The LNG storage tanks of the invention further comprise those facilities that are known in the art as re-

quired for LNG storage. Thus, the tanks will have, several LNG- and utilities-connections with external networks and internal pumps for pumping LNG out of the tank.

[0056] The invention brings about further advantages. In conventional tanks, the aforementioned height is reduced by the bottom minimum level and top margin to give, for instance, for a wall height of 37 meters a working height of LNG of about 30 meters. In preferred embodiments of the invention, a larger working height can be obtained in several ways.

[0057] One is related to columns that are normally present to accommodate internal pumps in the storage tank. By placing the bottom of this column in an insulated pit, some 2 to 2.5 meters height of the pumps suction head can be saved. This is allowed by the fact no displacement of the pit will result from thermal contraction of the membrane tank liner, contrary to a bottom comprising 9% Ni steel plates.

[0058] In the case of the "ANL tank" a preferred embodiment provides for installing the normally internal pumps outside of the tank, in the confined internal concrete cylindrical wall, and to feed them by piping branched through bottom of the cryogenic containment. This is allowed because, in this case, any leak will be confined in this internal wall. In this case, as another advantage, avoiding in-tank submerged limitations, the external pumps could be direct HP (High Pressure) pumps, thus avoiding a two stages pumping (LP in-tank pumps + external HP pumps).

[0059] In the case of the "PLP tank" by placing membrane insulation sandwich panels against the inside lower part of an arched roof, as a result of which the optimum height of the roof is used to provide the safety margin between available height of the internal containments system.

[0060] As a result, a significant saving in capacity is obtained for the same surface foot print and concrete shell. Or, in the alternative, a reduced foot print (as well as roof, slab and bottom work) for the same capacity.

[0061] For instance, a typical 1.620.000 m³ of LNG (about 1 billion m³ of gas) could be obtained with:

Either two parallelepipedic tanks, each with an internal working capacity of 810.000 m³, based on such internal concrete containment size:

- Width 61,0 m
- Length 361,0 m
- Wall height 37,0 m
- Working LNG height 37,0 m

[0062] Or two annular tanks of 810.000 m³ of working capacity based on such sizes:

- External wall inside diameter 187,0 m
- Internal wall diameter 60,0 m
- Wall height 37,0 m

- Working LNG height 34,5 m

[0063] Such solutions are to be compared with a conventional storage made with nine 180.000 m³ LNG conventional tanks of 90 m diameter. Both new solutions give more favorable surface/volume ratio (about 65 m² per 1.000 m³ to be compared to 85 m² for 1.000 m³ with the classical solution).

[0064] A major advantage is that the new designs require much less space and limit the number of internal equipments (pumps, instrumentation) and network connections, to two sets instead of 9.

[0065] In another aspect, the invention pertains to concrete structures some of which may have existed before in buildings for different purposes. The presence of an LNG-tight lining, the inlet and outlet, and one or more pumps readily distinguishes the concrete housing of the invention from edifices for other purposes. In one aspect, the invention relates to a concrete, membrane technology-lined tank as described hereinbefore, containing LNG.

[0066] In another aspect, the invention puts to use an LNG membrane technology (membrane technology as known in the field of LNG storage), for building on-shore concrete LNG storage facilities of increased capacity. In another aspect, the invention puts to use a concrete structure of the type described hereinbefore, for the storage of LNG.

[0067] Finally the overall saving of such storage tank over one classical tank of 9 tanks of 180,000 m³ is obtained:

- by a more favorable ratio between surface and volume, due to the larger unit tank size,
- by a better utilization as working LNG height of the internal membrane containment height within the given concrete shell,
- by reducing the number of tanks, and related internal equipments, network connections and space utilization, needed to implement a large LNG storage tank.

Claims

1. A storage tank for liquefied natural gas (LNG) comprising a prestressed concrete shell and a membrane type internal containment system wherein the concrete shell comprises a concrete slab substantially parallel to a ground surface, at least two concrete walls extending vertically from said slab, said walls defining an open space, wherein the open space is covered by a concrete roof, and wherein the floor, the walls, and the roof together form a closed compartment.
2. An LNG storage tank according to claim 1, having a volume of above 300,000 m³ while having a roof span of less than 90m.

3. An LNG storage tank according to claim 1, comprising two walls each of which define a closed compartment, said walls being concentric relative to each other.
4. An LNG storage tank according to claim 2, wherein the walls are annular.
5. An LNG storage tank according to claim 2 or 3, wherein the inner wall defines the outer wall of a storage compartment
6. An LNG storage tank according to claim 1, wherein the walls comprise four walls that are substantially perpendicular to each other.
7. An LNG storage tank according to claim 1, wherein the walls are segments of a single wall having a semi-circular or elliptical shape.
8. An LNG storage tank according to any one of the claims 1, 2, 4, or 5, wherein the roof is selected from a gabled roof, a hip roof, and an arched roof.
9. An LNG storage tank according to claim 3, wherein the roof is a domical roof.
10. A LNG storage tank according to any one of the preceding claims, which is partially buried with a lateral embankment, or fully buried.
11. An LNG storage tank according to any one of the preceding claims, comprising a pit in the concrete slab housing the lower part of a pumps' column.
12. An LNG storage tank according to claims 3 or 4, comprising a pumps' system in the internal space enclosed by the inner of the concentric walls, in fluid connection with the tank.
13. An LNG storage tank according to any one of the preceding claims, comprising LNG.
14. The use of a membrane-type LNG containment as a lining in an on-shore concrete LNG storage tank, as a lining in an on-shore concrete LNG storage tank, wherein the concrete comprises a structure comprising a concrete floor substantially parallel to a ground surface, at least two concrete walls extending vertically from said floor, said walls defining an open space, wherein the open space is covered by a concrete roof, and wherein the floor, the walls, and the roof together form a closed compartment, for the storage of LNG.
15. The use of a concrete structure comprising a concrete floor substantially parallel to a ground surface, at least two concrete walls extending vertically from

said floor, said walls defining an open space, wherein the open space is covered by a concrete roof, and wherein the floor, the walls, and the roof together form a closed compartment, and wherein the concrete structure comprises a lining in accordance with 5 membrane technology, for the storage of LNG.

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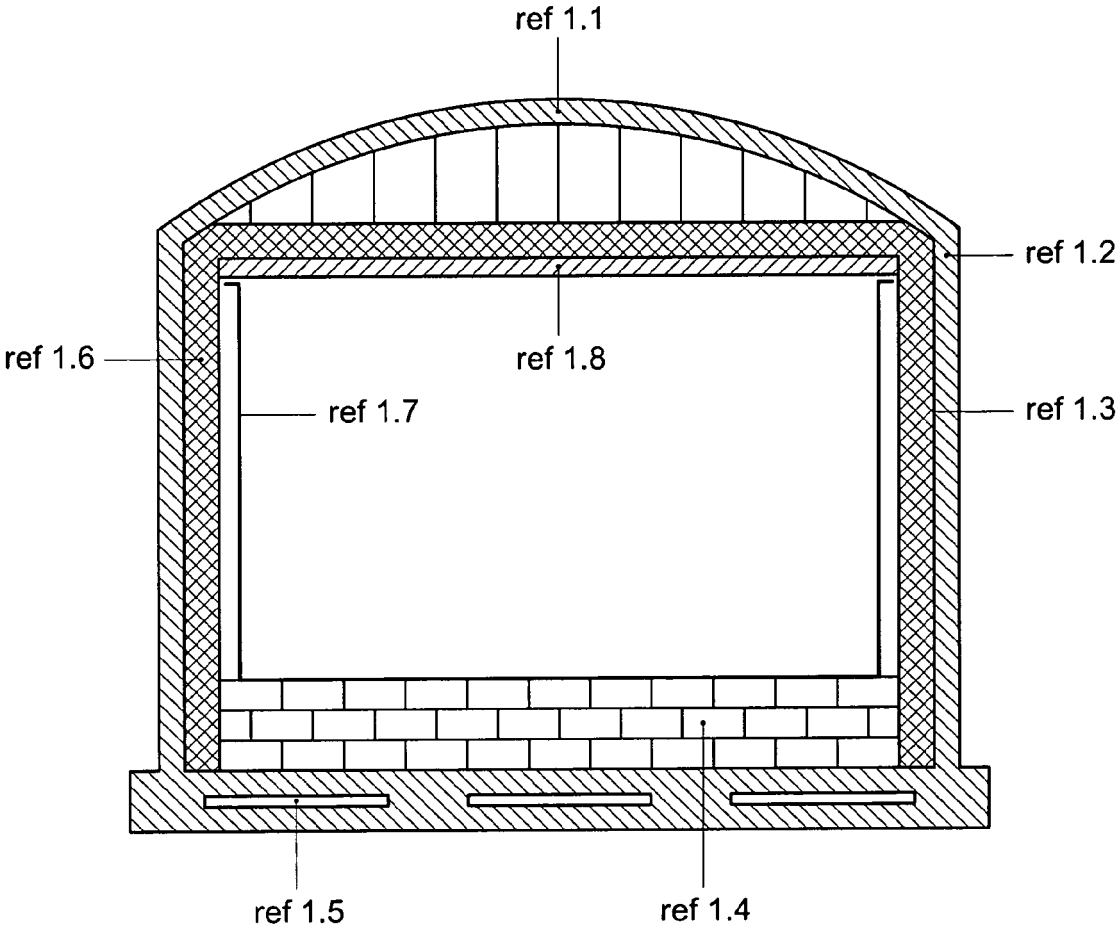


Fig. 1

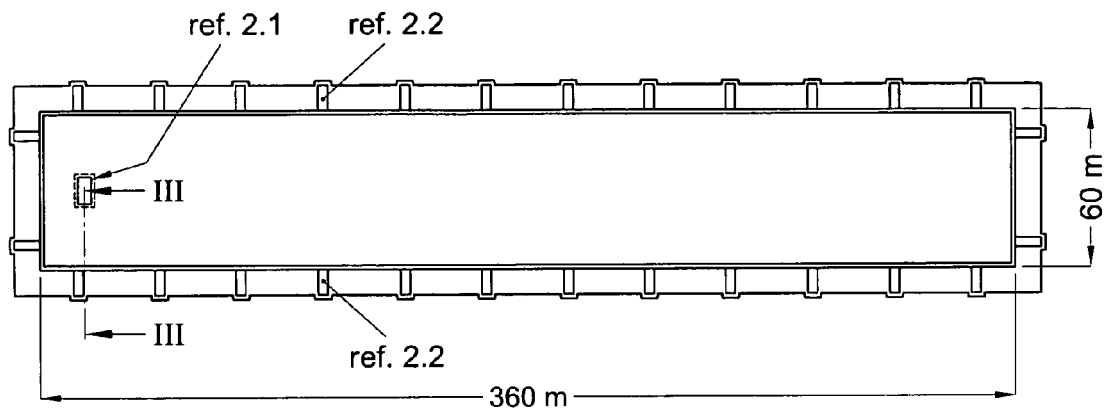


Fig. 2

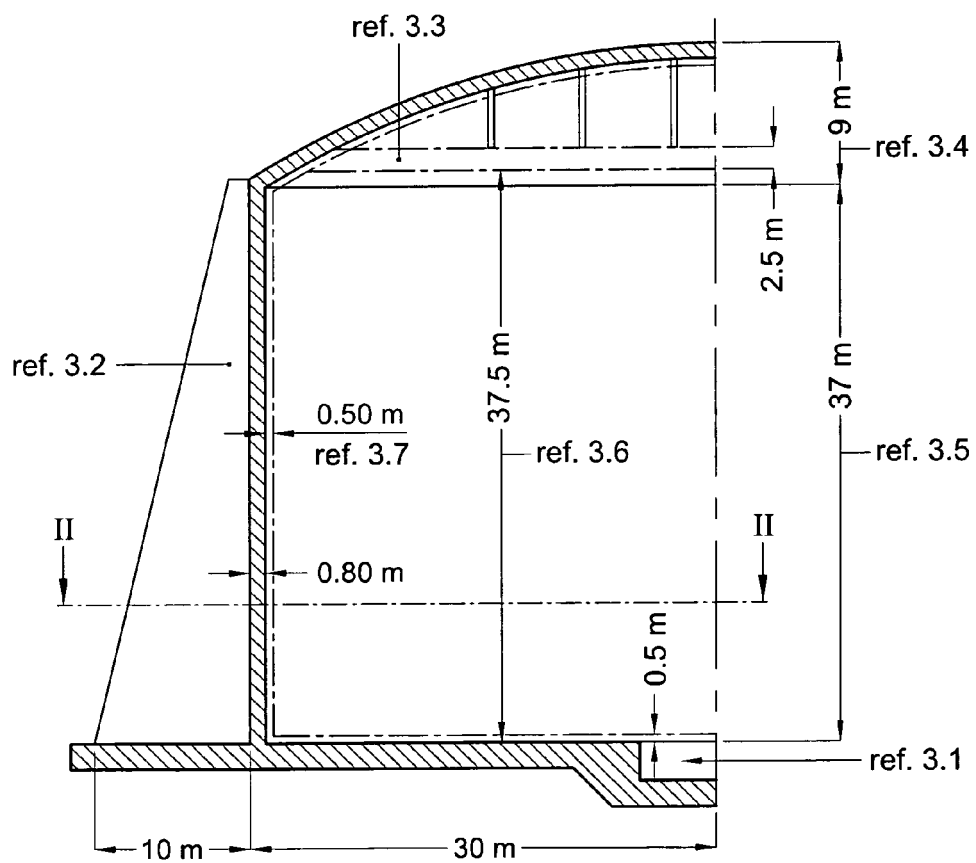


Fig. 3

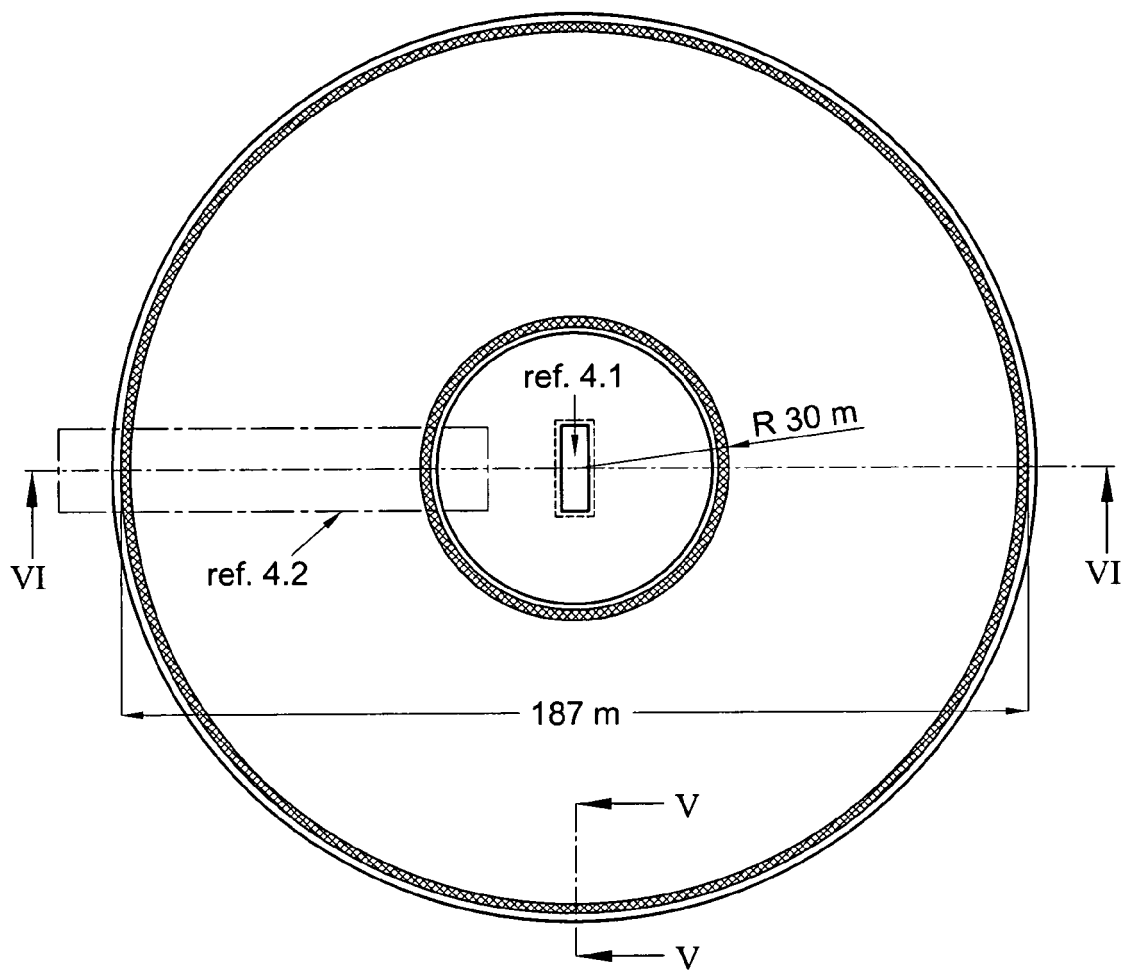


Fig. 4

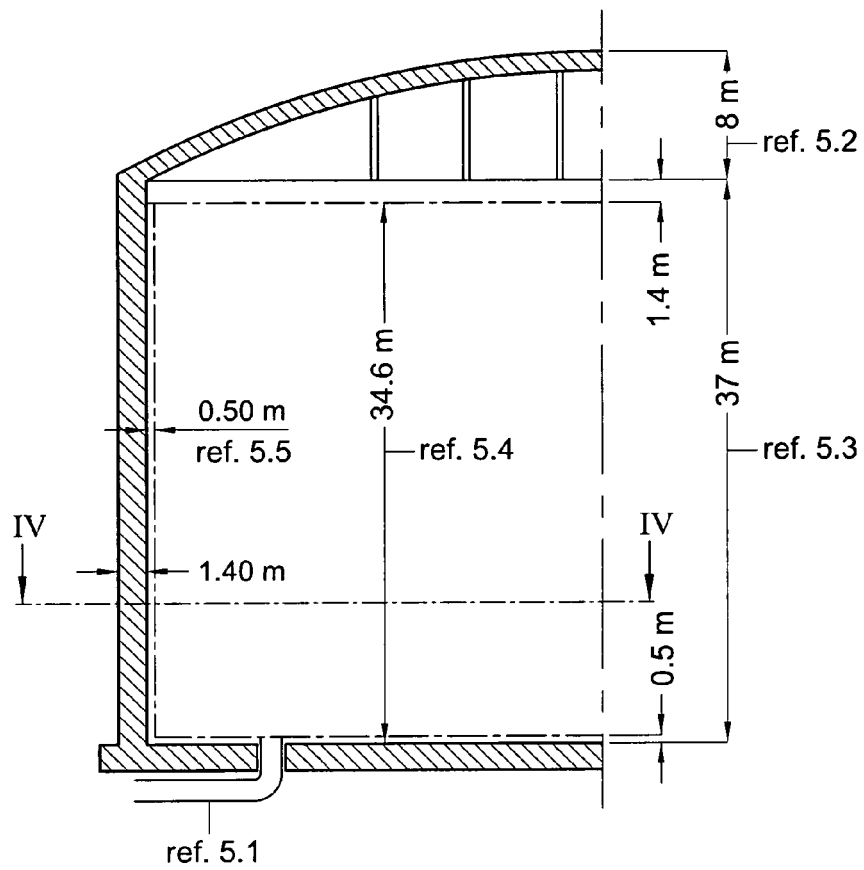


Fig. 5

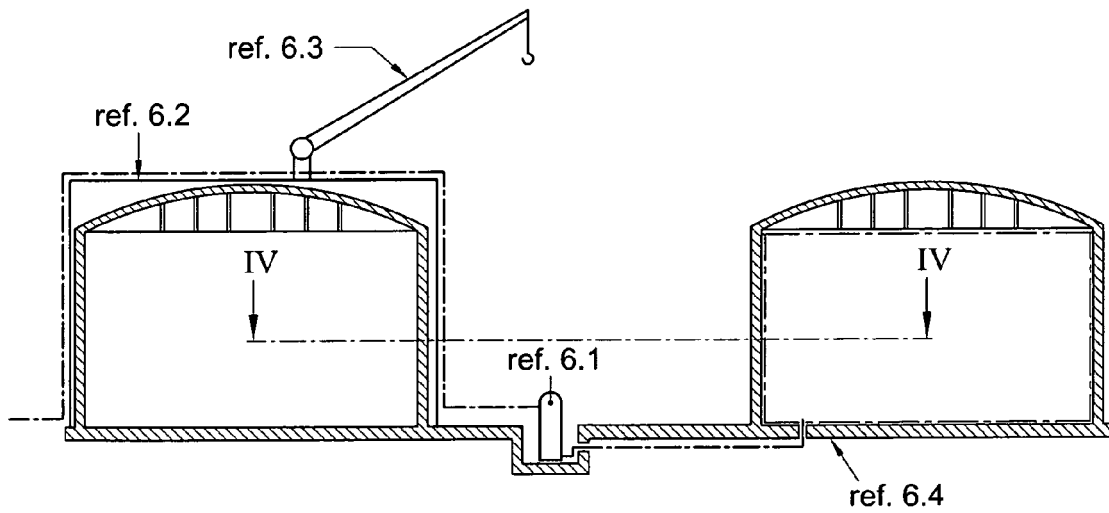


Fig. 6

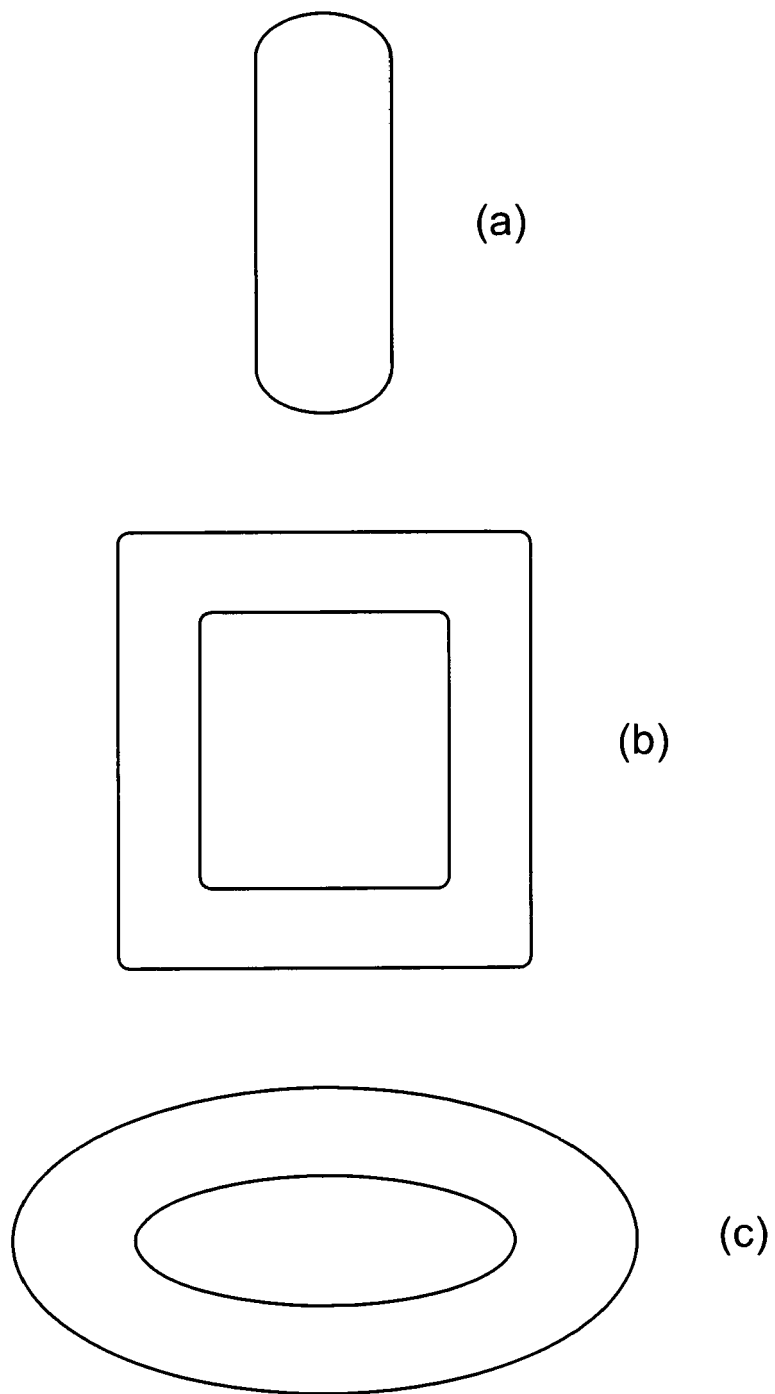


Fig. 7

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Reference list to figure 1, 2, 3, 4, 5, 6.

Fig. 1

- ref. 1.1 = Reinforced concrete roof
- ref. 1.2 = Pre-stressed concrete outer tank wall
- ref. 1.3 = Insulation on inside of outer tank wall
- ref. 1.4 = Base insulation
- ref. 1.5 = Bottom heater
- ref. 1.6 = Loose fill insulation or empty
depending on product store
- ref. 1.7 = Inner tank
- ref. 1.8 = Suspended roof (insulated)

Fig. 2

- ref. 2.1 = LP, pump pit
- ref. 2.2 = Buttress

Fig. 3

- ref. 3.1 = LP, pump pit
- ref. 3.2 = Buttress
- ref. 3.3 = Partial cupola insulation
- ref. 3.4 = Cupola height
- ref. 3.5 = Wall height
- ref. 3.6 = Working height
- ref. 3.7 = membrane insulation panels

Fig. 4

- ref. 4.1 = LP, pump pit
- ref. 4.2 = Platform

5 b

Fig. 5

- ref. 5.1 = LNG outlet to HP pumps
- ref. 5.2 = Cupola height
- ref. 5.3 = Wall height
- ref. 5.4 = Working height
- ref. 5.5 = membrane insulation panels

Fig. 6

- ref. 6.1 = HP pumps
- ref. 6.2 = Platform
- ref. 6.3 = Crane
- ref. 6.4 = Tank bottom outlet



EUROPEAN SEARCH REPORT

Application Number
EP 11 15 4318

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2006/003192 A1 (SHELL INT RESEARCH [NL]; SHELL CANADA LTD [CA]; FELIUS TANNO MAARTEN []) 12 January 2006 (2006-01-12)	1,2,6,8, 13-15	INV. F17C3/02
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	* the whole document *		

2 The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 December 2011	Examiner Nicol, Boris
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.02 (P04C01)



Application Number

EP 11 15 4318

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☒ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

1-9, 11-15

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION
SHEET B**

Application Number
EP 11 15 4318

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-9, 13-15

A storage tank according to claim 1, comprising further constructional details of the walls, roof of the storage tank as volume above 300.000 m3, or roof span of less than 9 meters.

2. claim: 10

A storage tank according to claim 1, wherein the tank is partially buried.

3. claims: 11, 12

A storage tank according to claim 1, comprising a pit in the slab for housing a pump's column.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 15 4318

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

02-12-2011

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