

PATENT APPLICATION

TITLE OF THE INVENTION

ALUMINUM ACCOMMODATIONS MODULE AND METHOD OF CONSTRUCTING
5 SAME

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10 CROSS-REFERENCE TO RELATED APPLICATIONS

This is a non provisional patent application of US
Provisional Patent Application Serial No. 61/372,922, filed 12
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Priority of US Provisional Patent Application Serial No.
15 61/372,922, filed 12 August 2010, hereby incorporated herein
by reference, is hereby claimed.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR
DEVELOPMENT

Not applicable

20 REFERENCE TO A "MICROFICHE APPENDIX"

Not applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to modular construction of
25 buildings. More particularly, the present invention relates to a
modular building constructed of Aluminum wherein the interior and
exterior walls are constructed as to not be connected, which
allows fire insulation blanketing therebetween to be a prime
barrier to potential fire hazards.

30 2. General Background of the Invention

In the marine transport and vessel regulation environment,
the USCG is charged with regulating the materials and methods by
which industry must conform in order to have a safe working
environment for personnel. Other similar governing agencies in
35 the world are the ABS (American Bureau of Shipping), DNV De

Norske Veritas and Lloyds Regulations which are also known as SOLAS (Safety of Life at Sea). Many of the regulations in place today stem from meetings of the world shipping organizations in the 1912 and 1970's. Many of the early regulations came as a
5 result of the Titanic catastrophe.

Historically, modular marine buildings exteriors have been constructed out of steel, which is quite heavy. There is a need in the industry for a modular marine building to be constructed of lightweight material, such as Aluminum, and in such a manner
10 that the building is vastly more safe against fire hazards.

BRIEF SUMMARY OF THE INVENTION

The present invention solves the problems in the art in a straightforward manner. What is provided is a modular building and a method of constructing a United States Coast Guard (USCG)
15 certified modular building for utilization on USCG approved vessels, as well as vessels under foreign flags, ABS, NV, and other regulating agencies, out of aluminum and special Firemaster Marine Blanketing material. Under the method of the present invention, the walls are constructed as to not be connected,
20 allow the fire insulation blanketing to be a prime barrier to potential fire hazards. Due to several reasons aluminum can be a better material than steel to utilize for the purpose of marine accommodations. First, Aluminum is considerably lighter, due to the crane capacities on offshore floating platforms and boats,
25 the lighter the building the safer it is to lift. Also, the lightweight on vessels serves to lighten the overall load reducing fuel consumption considerably. Aluminum exterior buildings can weigh half of what steel buildings do. Second and equally important is that aluminum does not corrode (oxidize)
30 nearly as fast as steel in a salt laden marine environment. Therefore, it is not necessary to install elaborate coating systems to try to protect the exterior of the aluminum buildings as must be done on steel buildings making the aluminum buildings much more maintenance friendly.

35 The design criteria that is novel and sets this as an

original invention, is the method by which the building is constructed with one interior structure separate from the exterior structure, thus making it virtually a building inside of a building. The insulation utilized is a blanket that meets all
5 criteria of the USCG for exterior (A-60 fire rating) on its own.

Thus, by having the interior walls being able to stand alone, then covered by the fire blanket insulation, this alone would constitute a safe environment for lodgers. Along with this, an external wall is added, (which is light weight as well) aluminum,
10 just to protect the fire wall blanket insulation from the exterior environment and to provide more structural safety for the building. Another added benefit to having the dual wall system is that it will provide even more air space for increase insulation benefit for greater efficiency for heating and cooling
15 the building. Applicants have designed and engineered a revolutionary method to have a certified, safe, and lightweight exterior wall design that can be utilized to construct all types of buildings for deepwater structures, marine vessels, and other floating structures. The design can be used to build USCG
20 certified accommodations, MCC's, offices, and other manned structures of all sizes. The wall design meets A-60 or H-60 fire ratings. It can be engineered to have a blast rating of as much as 1.5 bar static loading. The dual wall design has better insulation properties for increased protection from fire, heat,
25 cold, and sound. The design can be utilized to save up to half of the weight of conventional structures, whether it be a small modular building or a large multi-story single lift building.

Applicants' new USCG building is nearly half the weight of conventional steel buildings.

30 12 Man Sleeper Building (Aluminum) 12'0" x 40'0" (3.7 m x 12.2 m)

24,800 lbs. (11,249 kg)

12 Man Sleeper Building (Steel) 12'0" x 40'0" (3.7 m x 12.2 m)

48,000 lbs. (21,772 kg)

Offshore Oil and Gas Operators understand the advantage of
35 reduced weight, from loading, unloading, transportation, safety

and platform limitations.

Steel 3/16" (0.48 cm) thickness weighs 7.6 lbs/sq ft (37.1 kg/sq m).

Aluminum 3/16" (0.48 cm) thickness weights 2.7 lbs/sq ft (13.2 kg/sq m).

The many objects of the present invention are presented below:

A principal object is that Applicants' new building is constructed out of aluminum which does not need a coating system to ward off salt laden environments. The building's exterior is crimped plate aluminum and does not corrode in salt laden environments, making the building less costly and dangerous over time. Steel structures will eventually develop rusting and leakage, leading to dangerous moisture intrusion, along with compromised structural integrity, it can develop mold and bacteria growth making interior living spaces uninhabitable. Because of LQT's dual wall system design, even if there is a breach in an exterior wall the interior space is completely sealed and independent from the exterior wall, making it nearly impossible to have moisture intrusion. Over time the reduced maintenance cost will pay for the entire structure. It also has a considerably longer life cycle.

CORROSION RESISTANCE OF ALUMINUM

A second principal object is that Applicants' building has corrosion resistance of Aluminum. According to engineers, Aluminum has excellent corrosion resistance in a wide range of water and soil conditions, because of the tough oxide film that forms on its surface. Although aluminum is an active metal in the galvanic series, this film affords excellent protection in salt water environments.

HIGH BLAST RATING CAPABILITY

Another principal object is that Applicants' building has a high blast rating capability. The new design allows for a lightweight answer to the ever increasing safety concerns of catastrophic blasts. The new wall design can be engineered to

increase blast ratings from as little as .1 bar (10 kPa) to 1.5 bar (150 kPa) and still maintain the lightweight dual wall design. Due to the fact that the wall design is two completely separate walls, with no interconnecting parts, the exterior wall serves as a blast wall, while the interior wall remains structurally sound. This allows the design to have considerably higher protection against blast, making the interior much safer for the occupants. The new USCG/ABS Rental/Sale building wall design is .25 bar (25 kPa) blast certified.

IMPROVED INSULATION DESIGN

Another principal object is that Applicants' building has improved insulation design. The new dual wall design incorporates a 3' (0.9 m) thick layer of Firemaster A-60 insulation blanketing the entire building. The insulation is tested at extreme temperatures to offer protection from open flames, but along with its fire protection capabilities, the insulation has a very high R factor when combined with the 4" (10 cm) airspace in the wall design. Air is the best insulating material. In addition to this, the air in the space, is circulated through the buildings HVAC system, for added heating and cooling benefits.

IMPROVED SOUND REDUCTION DESIGN

Another principal object is that Applicants' building has improved sound reduction design. The wall design and interior products discourage noise pollution. Along with the inside wall air space the insulation provides noise reduction capabilities. The building reduces sound decibels by as much as 30% over the conventional steel building single wall design. This obviously makes the building more comfortable for its occupants.

INTERIOR DESIGN STATE OF THE ART

Another principal object is that Applicants' building has state of the art interior design. The interior components are all state of the art fire safe comfortable and USCG approved materials. Living Quarter Technology has years of experience providing accommodations to the Offshore oil and gas business. The company provides pillow top mattresses with oversize bedding

along with comfort quiet curtains for privacy. The building has oversized HVAC capacity for heating and cooling in extreme environments. All the latest safety features are incorporated in the unit, including fire and gas detection systems and smoke
5 detection. The system has emergency lighting that maintains full lighting throughout the building in case of loss of power.

LOWER OVERALL COSTS OF CONSTRUCTION

Another principal object is that Applicants' design has lower overall costs of construction. Although the costs of
10 aluminum is a little higher than raw steel, due to the fact that the building does not need to have a coating system, the overall capital costs of the building is approximately 10% less than a conventional similar steel building. This along with the fact that the building has better insulation properties and lower
15 maintenance costs, easily make it a better overall value.

23,200 lbs (10,523 kg) Lighter

Another principal object is that Applicants' building is much lighter than conventional offshore buildings. Offshore Oil and Gas Operators understand the advantages of reduced weight
20 from loading, unloading, transportation, safety and platform limitations. Nearly have the weight of conventional steel buildings: compare our aluminum 12-man-sleeper at 24,800 lbs (11,249 kg) to a steel 12-main sleeper at 48,000 lbs (21,772 kg).

Low Maintenance

Another principal object is that Applicants' building's exterior of crimped plate aluminum does not corrode in salt-laden environments, making the building less costly, safer, and giving it a considerable longer life cycle. Over time the reduced maintenance cost will pay for the entire structure. Because of
30 LQT's dual wall system design, even if there is a breach in the exterior wall, the interior space is completely sealed and independent from the exterior wall, making it nearly impossible to have moisture intrusion.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

For a further understanding of the nature, objects, and

advantages of the present invention, reference should be had to the following detailed description, read in conjunction with the following drawings, wherein like reference numerals denote like elements and wherein:

5 Figure 1 illustrates a top view of the living quarters component of the modular aluminum modules in a preferred embodiment of the present invention;

10 Figure 2 illustrates a top view of the outer protective shell component of the modular aluminum modules in a preferred embodiment of the present invention;

 Figure 3 illustrates a partial corner view of the insulation enveloping the living quarters in the modular aluminum modules of the present invention;

15 Figure 4 illustrates a top view of the composite accommodations module of the present invention where the outer protective shell has been positioned over the living quarters component;

20 Figure 5 illustrates a plurality of six accommodations modules of the present invention positioned in a single group for occupation by workers;

 Figures 6 through 8 illustrate views of the anchor system of the present invention which engage modules stacked upon one other to avoid upper modules from disengaging from the modules below;

25 Figure 9 illustrates a top view of the roof framing plan of the modules of the present invention;

 Figure 10 illustrates a top view of the floor framing plan of the modules of the present invention;

30 Figures 11 through 14 illustrate the corner construction between the outer protective shell and the inner housing quarters in the module of the present invention;

 Figures 15A and 15B illustrate the dynamics involved when the outer protective shell is impacted by a blast impacting a module of the present invention;

35 Figure 16 illustrates an additional view of the wall construction interconnecting with the floor of a module of the

present invention;

Figures 17 and 18 illustrate views of the attachment of the lifting padeyes which are engaged when lifting a module of the present invention; Figure 17 illustrates a top view of the reflective ceiling plan of the present invention;

Figures 19 through 21 illustrate additional views of the manner in which the insulation blanket is secured to the outer surface of the living quarters wall in the present invention;

Figures 22 and 23 illustrate cross-section views of the air flow system and the manner of insulation in the module of the present invention;

Figure 24 illustrates a top view of a typical the six-man galley of the present invention; and

Figure 25 illustrates a partial top view of the module of the present invention where the insulation is positioned to the exterior of the four corner posts, so that structural corners supporting an upper building are inside the insulation blanket to prevent destruction by fire, blast or other catastrophic event.

DETAILED DESCRIPTION OF THE INVENTION

Figures 1-25 illustrate a preferred embodiment and the modular accommodations module and method of erecting same in the present invention. First, in a discussion of the overall invention, reference should be first made to Figures 1-4 which illustrate the accommodations module 10 (hereinafter called module 10), which comprises an interior living quarters constructed of aluminum placed within an exterior protective shell 14, which is also constructed of lightweight aluminum, with the walls of the exterior protective shell 14 having no contact whatsoever in the wall space there between.

As seen first in Figure 1, there is illustrated the substantially rectangular interior living quarters 12 having a pair of parallel side walls 17 and 19 and end walls 20 and 22 with doorways 24 therein. There is further provided a ceiling portion 26 and a floor portion 28, all of which define the interior living quarters 12. As stated earlier, the four walls, ceiling and floor of this living quarters 12 would be constructed of a lightweight aluminum and welded together as a single unit so that it would form a continuous non-interrupted aluminum shell 30 defining the living quarters 12 there within. As illustrated, the walls of the living quarters 12 would be held in place with a plurality of vertical C beams 15 along the walls, and the floor 28 would be raised above the ground when the living quarters 12 is resting on the ground.

In Figure 2, there is illustrated the exterior protective shell 14, constructed of lightweight aluminum sheets 23, and being of a length and width larger than that of the living quarters 12, for the reasons to follow. The aluminum sheets 23 would form a pair of side walls 32 and 34, end walls 36 and 38 with doorways 40 which would line up with the doorways 24 of the interior living quarters 12. The exterior protective shell 14 would likewise include an upper roof 42, which together with the side walls and end walls would define the protective shell 14 enclosure. It should be noted that the aluminum sheets 23 extend the entire height of the side walls 32, 34 and end walls 36, 38, as seen in Figure 5, for reasons to follow. The walls of the protective shell 14, would also be held upright with a plurality of spaced apart C beams 35, slightly larger in size than the C beams 15 supporting the walls of living quarters 12.

In Figure 3, there is illustrated a section of insulation 50 of the type preferably having A-60 fire rating, that was discussed earlier in the application. The insulation 50 would be placed along the entire outer surface 52 of the sidewalls 17, 19, end walls 20, 22, ceiling 26 and floor portion 28, of the living quarters 12, so as to define a continuous layer of insulation 50

enveloping the entire living quarters 12. It is critical that the entire outer surface of living quarters 12 be covered by the continuous layer of insulation 50. Following the enveloping of the living quarters 12 with insulation 50, as seen in Figure 4, because the living quarters 12 is of smaller dimensions than the exterior protective shell 14, the shell 14 would be lowered down upon the living quarters 12, so that the protective shell 14 would completely envelope the living quarters 12, and the lower ends of the walls of the protective shell 14 would extend to the very lower edge of the walls of the living quarters 12. Once the protective shell 14 is in place over the living quarters 12, this would define the composite module 10, and would cover the structural skid beams for greater stability in case of a fire or blast event.

It is of critical importance as seen in the Figures, that the insulation 50 and C beams 15 which are surrounding the interior living quarters 12 make no contact whatsoever with the C beams 35 on the inner surface 33 of protective shell 14, as seen in Figure 3. This is possible because of the larger dimensions of protective shell 14. Therefore what is defined is a continuous air space 60 entirely surrounding the walls and ceiling of the living quarters 12 and the walls and ceiling of protective shell 14. This air space 60 is critical, as will be explained further.

Turning now to Figure 5, there illustrated a front view of a series, in this case, six modular units 10, two of which have been set side by side and four which have been stacked thereupon to form the composite six unit living quarters 12 therewithin. It should be noted that each of the side walls 32, 34 and end walls 36, 38 of each module 10 are formed of exterior aluminum panels 23 which extend from the upper point 25 of each module 10 to the lower most point 27 of each module 10. This is critical since this aluminum protective shell 14 would allow no heat nor any kind of force to contact the inner air space 60 between the outer walls of the protective shell 14 and the walls of the

interior living quarters 12 without contacting first the aluminum sheets of the walls of the protective shell 14, and all main structural beams for greater stability in hazardous conditions.

It should also be noted in Figure 5 that there is shown a group of six modules 10, the group being a lower pair of modules 10 supporting two pairs of modules 10 thereupon. First, there is illustrated a plurality of exterior bolting connections 64 between the two lower side by side modules 10 of the six, and the two pairs of upper modules 10 resting on the lower modules 10.

As seen in Figure 5, and as discussed more in detail in Figures 6 through 8, the upper most pair of modules 10 each include a plurality of upright anchor members 66, which are extending out from the roof 42 of each of the modules 10. Likewise, the floor 28 of each module 10 would have a plurality of corresponding recesses 68 so that when a module 10 is placed upon a lower module 10, the upright anchor members 66 are each stabbed into a corresponding recess 68 of the upper module 10, so that the upper module 10 is held firmly in place atop the lower module 10. For purposes of safety, it is critical to note that the anchor members 66, which are shown in position on the roof of a module 10 in Figures 5 and 7, are positioned on the upper surface or roof of each of the modules 10 at points interior to the walls of the living quarters 12. Through such placement, the connections between the upper and lower modules 10 will not be compromised by heat or blast, which if they were not, may result in the collapse of the outer edge of the protective shell 14, and result in the upper module 10 toppling off of the lower module 10.

As seen in detail in Figures 6 through 8, there is a view of a typical anchor member 66 which extends upward from the roof of each of the modules 10. There is seen a base plate 72 wherein the vertical anchor member 66 extends upward which would fit into a recess 68 of the module 10 above it. It is seen that when the uppermost anchor member 66, as seen for example in Figure 5, will have no module 10 placed thereupon; therefore, there is

positioned an insulated cap 76 which would fit on to the anchor member 66 so that should heat engage the exterior of the module 10 in the course of a fire or blast, the heat could not travel through the anchor member 66 down into the living quarters 12.

5 The insulated cap 76 would prevent the heat from gaining access there through. Of course when a module 10 has a second module 10 stacked upon it, the heat cannot get into it so it would not need an insulation in that regard.

10 Figures 9 and 10 are views of the roof framing plan and floor framing plan, respectively. It should be noted in Figure 9 that the anchor members 66 are shown in the four corners of the composite module 10 again, as stated earlier, with each of the anchor members 66 being set interior to the walls of the living quarters 12, to avoid being subjected to outer blast force or
15 heat when heat or blast would strike the exterior protective shell 14. This again, as was stated earlier, is to avoid the outer wall of the protective shell 14 of the module 10 from collapsing causing the upper module 10 to topple. The position as shown would also prevent any heat from entering the living
20 quarters during a fire or blast event.

Turning now to Figures 11 and 12, these figures show upper views of the exterior wall 36 as it engages a corner support post 80 with a view of C beam 35 holding the wall 36 upright throughout its length. There is also seen an interior support
25 post 82 which would engage the inner walls 17, 19 of the living quarters 12, likewise having a C beam 15 supporting it. Again, and it cannot be stressed enough, that it should be noted that there is a void space 60 between the two walls and the C beams 15, 35 so that there is no metal contact of any type between the
30 walls of living quarters 12 and the walls of protective shell 14.

Turning to Figures 13 and 14, there is illustrated a side view of the base of the module 10 wherein there is a base plate 90 that supports the outer walls of protective shell 14 through welding of the like and the wall of the living quarters 12, where
35 the floor 28 is engaged. As seen in Figure 13, when the inner

support post 82 is in place, the floor 28 of the living quarters is welded thereupon. Again, there being a void space 60 between the walls of the living quarters 12 and outer protective shell 14 which is filled with air and may be filled with insulation for the reasons as discussed earlier.

In Figure 16 there is illustrated again, an additional side view of the base plate 90 upon which the supports for the walls of living quarters 12 and protective shell 14 are engaged. Again, there is provided L-brackets 94 which support the floor 28 of the inner living quarters unit 12 and again, there is the air space void 60 between the wall of the protective unit 14 and the wall of the living quarters 12. A portion of this space 60 as will be discussed further, will be filled with insulation as was seen in earlier figures. A discussion of the dynamics of Figure 15 will follow more in detail.

Turning now to Figures 17 and 18, these are views of the lifting pad-eye 95, which would be at the four positions on the roof 42 of each of the modules 10 for lifting each module 10, as seen in overall view in Figure 9. Again, these lifting pad-eyes 95 are positioned interior of the wall of shell 14 so as to be unaffected by any heat or blast that may engage the outer shell 14 during fire or a blast event. The body 97 of each pad-eye 95 is within the protective interior of the living quarter 12, with only the eyelet portion 99 extended outward for being engaged by a lifting hook during movement of the module.

In Figures 19-21, there is illustrated again another view of the continuous segment of insulation 50 which fills part of the void space 60 between the wall of the living quarters 12 and the outer protective 14. This insulation 50 is engaged into the inner wall via engaging pins 55 spaced apart so that the insulation 50 is held in place throughout the entire height of the wall of the living quarters 12. Also, as illustrated, the blanket of insulation 50 wraps to the exterior of the C beams 15 which are supporting the walls of living quarters 12. Again, it should be made clear that the insulation 50 occupies some of the

void space 60 between the wall of the living quarters 12 and protective shell 14, but makes no contact whatsoever with the outer wall of the protective unit 14 and no contact whatsoever with any of the C beams 35 of the outer protective shell 14.

5 Figures 22 and 23 illustrate the insulation 50 it is protecting the flow of air (Arrows 100) from the Air Vac system supply air into and out of the living 12 for the comfort of the occupants during use. The insulation 50 is positioned in such a manner so that should a blast occur, the blast force or heat
10 would not enter through the air duct 102 of the air delivery system as seen in the figures.

 In Figure 24, there is illustrated a top view of a typical living quarters 12 within the interior shell, interior accommodations module 10. For example, there is a series of six
15 beds 110 that would house six workers; while other accommodations modules 10 may include additional features such as meeting quarters, desks, a kitchenette of the type that would be used for people who will be working and spending time out on a rig or oil production platform. Figure 25 illustrates a very important
20 aspect of the construction of the module 10. Although Figure 19 illustrated an upper partial view of a single corner of a typical module 10, Figure 25 illustrates all four corners of the module 10 wherein each of the four corner posts 82 are positioned interior to the insulation 55 which envelopes the interior
25 structure 14. This is very critical, since the corner posts 82 are the principal support members which would support an upper module 10 being supported by a lower module 10. The positioning of the insulation as seen in Figure 25 would prevent any heat from a fire event, or force from a blast to compromise the
30 support integrity of the support posts 82. This would insure that the upper supported modules 10 would not topple off of the lower support module 10 should the modules 10 be subjected to intense heat or force from a fire or explosion on the rig or platform.

35 Reference again is now made to Figures 15A and 15B. As

stated earlier, one of the critical aspects of this invention as was discussed earlier, is a fact that the inner wall of the living quarters 12 and the outer protective shell 14 make no contact whatsoever, and are separated by the void space 60 partly occupied by insulation 50 as seen in Figure 15A. This is vital since in the event for example of a blast 120, as seen in Figure 15B, the force of the blast 120 which would last less than a second would make initial contact with the wall of the outer protective shell 14, and in doing so, would force the wall of the shell to move inward toward the wall of the living quarters 12. The void space 60, between the units 12 and 14 would house the insulation 50, and would be filled with air 125 to impact buffer some of that force. However, the air 125 would become compressed, and would act as a force against the wall of the living quarters 12. Therefore, when the blast occurs, there are included vents 126 in that portion of the interior space 60 below the floor 28 of the living quarters 12, as seen, for example, in Figure 15. When the air void 60 is compressed by the blast, the air 125 is allowed to vent through these vents 126, and therefore, would not serve as additional force against the wall of the living quarters 12. Additionally, if the blast or fire is sufficiently hot, the heat of the blast 120 would affect the insulation 50, and due to its ceramic nature, the 50 would tend to melt and fill any void against the wall of the living quarters 12, and would again act as a "plastic" protective insulated shell so that the heat of the blast again would not be able to enter the living quarters 12. It is through this two wall construction of these modules 10 which allows the outer protective shell 14 of the modules 10 to take enormous amount of force from the blast or enormous heat from the fire and be able to maintain the heat from the blast of the fire within that space between the inner and outer walls of the module so that the heat or the force of the blast does not enter the interior space of the housing quarters 16 where the men are housed during such an event.

Design Criteria and Other Data for Module

Having discussed the accommodations module 10 as illustrated in Figures 1 through 24 above, what follows is a discussion of other important criteria in the design and construction of the modules 10 in the preferred embodiment.

The aluminum accommodations modules 10 of the present invention are to be constructed of aluminum in lieu of steel. Preferably, building sizes range from a 12' x 20' x 10'-6" (3.7 m x 6.0 m x 3.2 m), to 16' x 70' x 10'-6" (4.9 m x 21 m x 3.2 m), the example for this purpose in the drawings which are expected will be a common dimension is 12' x 40' 9 5/8" x 10'-6" (3.7 m x 12.4 m x 3.2 m).

The accommodations module 10 of the present invention underwent rigorous engineering tests to insure that is novel features were feasible in the field. Through these tests it has been shown that the inventors have engineered a method to construct a USCG certified modular building for utilization on USCG approved vessels, out of aluminum and special Firemaster Marine Blanketing material. This method by which the walls are constructed as to not be connected, allow the fire insulation blanketing to be a prime barrier to potential fire hazards. Historically, modular marine buildings exteriors have been constructed out of steel. Due to several reasons aluminum can be a better material to utilize for the purpose of marine accommodations. First, Aluminum is considerably lighter, due to the crane capacities on offshore floating platforms and boats, the lighter the building the safer it is to lift. Also, the lightweight on vessels serves to lighten the overall load reducing fuel consumption considerably. Aluminum exterior buildings can weigh half of what steel buildings do. Second and equally important is that aluminum does not corrode (oxidize) nearly as fast as steel in a salt laden marine environment. Therefore, it is not necessary to install elaborate coating systems to try to protect the exterior of the aluminum buildings

as must be done on steel buildings making the aluminum buildings much more maintenance friendly.

The design criteria that is novel and sets this as a unique invention, is the method by which the building is constructed with one interior structure separate from the exterior structure, thus making it virtually a building inside of a building. The preferred insulation utilized is a blanket that meets all criteria of the USCG for exterior (A-60 fire rating) on its own.

Thus, by having the interior walls being able to stand alone, then covered by the fire blanket insulation, this alone would constitute a safe environment for lodgers. Along with this there can be added an external wall (which is light weight as well) aluminum, just to protect the fire wall blanket insulation from the exterior environment and to provide more structural safety for the building. Another added benefit to having the dual wall system is that it will provide even more air space for increase insulation benefit for greater efficiency for heating and cooling the building.

The subject module has been designed in accordance with USCG RP 98-01, Eighth District Interim Recommended Practice-Plan Approval, Certification and Installation of Accommodation Modules. It is intended that the subject building be used on Fixed Offshore Platforms, floating structures and MODU's. (Marine vessels of all sorts)

The Lifting and Operating calculations were based on an Elastic Analysis as per American Aluminum Association, Allowable Stress Design 2005. All calculations are based on welded allowable stresses values, resulting in a higher factor of safety.

The structural framing and cladding was designed for the following conditions;

Lift (Dynamic)

Operating Single

Operating Double Stacked and Single Wide
Operating Triple Stacked and Double Wide
Interior Structure, Triple Stacked

In the structural design, normal allowable stress was used in
5 design (no $1/3$ increase in allowable). Deflection of major
members was limited to $L/360$ where L = member unsupported length
(in). Unity checks on members was limited to <1.00 (Utilization
Ratio).

The Primary structural framing and cladding were modeled with "
10 STAAD PRO" Structural Analysis software.

Preferred Materials:

Structural Fire Protection Insulation: Shall comply with USCG
NVIC 9-97, ABS Rules and 46CFR Part 164.

Insulation: 2" (5 cm) Thick "Firemaster Marine Blanket", Calcium
15 Magnesium - Silicate Fiber Insulation (USCG Approval Number:
164.107/1/0)

Electrical: The electrical components, wiring and bulkhead cable
transits shall comply with 46CFR Subchapter J and USCG NVIC 9-97.

Construction: Walls, floors and ceilings are constructed to have
20 two layers of Aluminum plate with support beams and 2" (5 cm)
Firemaster Marine Blanket sandwich between the Aluminum Plates.

Approvals:

United States Coast Guard

USCG evaluated a typical all-aluminum wall designed by
25 Applicants' for structural blast performance. As originally
designed, the wall system consists of an exterior layer made of a
 $3/16$ " (0.48 cm) flat plate supported by C6x2.83 stud channels at
24" (61 cm) spacing o.c. The interior layer is made of a $1/8$ "
(0.32 cm) flat aluminum plate supported by C3x1.42 stud channels
30 at 24" (61 cm) o.c. The height of the wall is 9 ft (2.7 m), edge
to edge. Applicants requested that the engineering evaluation
analyze the walls as if they were fixed at both ends; however,

the engineering evaluation did not include the review of any header or sill in the analysis.

The aluminum alloy - temper used is 6061-T6. Mechanical properties for this material were obtained from an Alcoa catalog
5 Since blast response limits for structural aluminum have not been published, engineering evaluation used engineering judgment in extrapolating response ductilities from published figures for ductile steel. The criteria compares the ratio of elongation at a given damage level to ultimate elongation for ductile steel, and
10 uses the same ratios to the ultimate elongation of 6061-T6 aluminum. As for ultimate end rotations, the same response limits as for ductile steel were assumed.

The applied design pressure is 0.25 bar (25 kPa) as requested by LQT. Duration of the positive phase was calculated
15 in accordance with API RP- FB2 and found to be 608 msec. The engineering evaluation analyzed each structural component with a Single Degree of Freedom (SDOF) approach using proprietary software. The deflection of the external wall causes a secondary pressure over the internal wall, which was determined using the
20 engineering evaluation Shield Pressure Prediction design tool; this pressure-time function was then used to load the internal layer and determine its response.

The scope of this work does not include optimization of the individual components to maximize performance and/or minimize
25 construction cost. Based on the engineering evaluation, it is Applicants' opinion that the wall system could be rated for higher loads with some modifications.

Wall System

The structural components of the walls are made of 6061-T6
30 aluminum. Based on information from Alcoa's catalog, mechanical properties for this alloy - temper are as follows:

Typical minimum yield tensile strength = 35 ksi (241 MPa)

Typical minimum ultimate tensile strength= 38 ksi (262 MPa)

Typical ultimate elongation = 8% up to 1/4" (0.6 cm)

10% for 1/4" (0.6 cm) and thicker

Typical modules of elasticity = 10,000 ksi (68,947 MPa)

All joints shall be made of 5183 aluminum welding wire. Based on information obtained from U.S. Alloy Co.'s catalog¹, ultimate tensile strength is 41 ksi (282 MPa). AS proposed by Applicants, studs shall be welded to plates by means of fillet welds of throat thickness not to exceed the thinner part to be connected, with a 3" (7.6 cm) fillet every 12" (30 cm) pitch.

Loads

As requested by Applicants, the system shall be verified for a peak applied pressure of 0.25 bar (25 kPa), equivalent to 3.63 psi (25 kPa).

Duration of positive phase was calculated in accordance with API RP-2FB, par. C.6.3.3:

$$t^* = 0.084 + 13,000/P$$

where t^* = duration of positive phase in seconds

P^* = nominal overpressure in Pascals (1 bar = 100,000 Pascals)

$$P = 0.25 \text{ bar} = 25,000 \text{ Pascals}$$

Therefore, $t^* = 0.604$ sec, approximately 600 msec. This is a very long event for typical blast scenarios, therefore duration estimation is considered to be on the conservative side.

In accordance with API RP-2 FB par. C.6.3.3, the load function is assumed to be symmetrical triangular (centrally peaked at $t^*/2 = 300$ msec).

Structural Response

The dynamic response of structural components under the predicted blast loads is determined by the components as Single-Degree-of-Freedom (SDOF) systems such as the equivalent spring-mass system shown in Figure 2. The SDOF model for each component is constructed using the component's mechanical properties so the model exhibits the same displacement history as the point of maximum deflection in the component. The displacement history of the SDOF model is obtained with finite difference techniques using computer programs to solve the equation of motion of the equivalent system at discrete time steps.

The calculated peak deflection is used to determine the support rotation and ductility ratio, which represent the deformation limit criteria (or damage levels) most commonly used in blast design. The support rotation is the angle between the original shape of a component and a straight-line segment between the point of maximum deflection and the support. The ductility ratio expresses the maximum deflection in terms of the maximum elastic deflection of the component. Therefore, ductility ratios that are greater than 1 indicate that permanent deformations have been sustained.

Aluminum Response Limits

As stated above, the most commonly accepted guidelines for the design and analysis of blast-loaded structures, such as ASCEⁱⁱ and API RP-2FP do not include response limits for structural aluminum. Therefore, the engineering evaluation adopted response limits based on an analogy with ductile steel. An example is given below:

A36 steel properties:

Yield tensile strength = 36 Ksi (248 MPa)

Ultimate tensile strength = 58 ksi (400 MPa)

Ultimate elongation = 15%

Modulus of elasticity = 29,000 ksi (199,947 MPa)

Strain at yield = $36/29,000 = 0.124\%$

Medium response ductility limits (ASCE) = 10

Strain at medium response limit = $10 \times 0.124\% = 1.24\%$

Ratio of strain at medium response limit/ultimate elongation = 0.083

Apply same ratio to aluminum:

Ultimate elongation for average channel thickness (interpolation) = 9.1%

Strain at medium response limit = $0.083 \times 9.1\% = 0.75\%$

Strain at yield = $35/10,000 = 0.35\%$

Medium response ductility limit = $0.75/0.35 = 2.15$, approximately 2.

Using similar criteria, ductility response limits for different damage levels and aluminum components are shown in Table 1:

5 **Table 1. 6061-T6 Aluminum Proposed Ductility Response Limits**

Component	Low Response*	Medium Response*	High Response*
Stud channels	1	2	4
Wall plates	1	2	4

*Component response limits are defined by ASCE1 as follows:

Low: Component has none to slight visible permanent damage.

10 **Medium:** Component has some permanent deflection. It is generally repairable, if necessary, although replacement may be more economical and aesthetic.

High: Component has not failed, but it has significant permanent deflections causing it to be unrepairable.

Secondary Pressure over Internal Wall Components

15 As the exterior wall plate and studs react to the applied pressure, it deflects. The deflection vs. time function is provided as output of the SDOF model. This deflection compresses the air between the external and the internal layers, causing a secondary pressure over the internal wall components. This pressure is a function of the air gap between the wall layers:
20 the wider the spacing, the smaller the pressure.

External Wall Plate

25 The 3/16" (0.48 cm) thick wall plate, spanning 24" (61 cm), assumed to be fixed-fixed (wall plate joints are assumed to be fully welded, and end spans should be reduced slightly [engineering evaluation suggests 20 inches (51 cm)] to compensate for lack of fixity at wall corners) has a predicted peak end rotation of 2.7 degrees, peak ductility 0.41, with a maximum deflection of 0.57 inches (1.4 cm) at 300 msec. Based on the postulated response limits, this is a Low response (acceptable).

External Stud Channels

The C6x3.42 stud channels spanning 9 ft (2.7 m), assumed to be fixed-fixed as indicated by LQT, have a predicted peak end rotation of 1.4 degrees, peak ductility 0.41, with a maximum deflection of 1.33 inches (3.4 cm) at 300 msec. Based on the postulated response limits, this is considered a Low response (acceptable).

Since both plate and stud deflections peak at about 300 msec, they can be added directly to obtain the peak deflection for secondary pressure calculations ($0.57 + 1.33 = 1.90$ in (4.8 cm) @ 300 msec). The response of both external components is elastic (ductility < 1). The peak secondary pressure obtained with our Shield Pressure Prediction Tool is 3.6 psi (25 kPa) at 300 msec.

Internal Wall Plate

The 1/8" (0.32 cm) thick wall plate, spanning 24" (61 cm), assumed to be fixed-fixed (same as external) has a predicted peak ductility that exceeds the proposed High response limit (unacceptable).

Internal Stud Channels

The C3x1.42 stud channels spanning 9 ft (2.7 m), assumed to be fixed-fixed as indicated by Applicants, have a predicted peak end rotation and peak ductility well in excess of Medium response limits (unacceptable).

Note that composite action on the stud channels cannot be assumed since deformation of the plate is too high to be assumed as collaborating in vertical flexure.

Internal Wall Plate

The 1/8" thick wall plate, spanning 12" (30 cm), assumed to be fixed-fixed (same as external) has a predicted peak end rotation of 1.1 degrees, and peak ductility of 0.23. This is considered a Low response (acceptable).

Internal Stud Channels

The C3x1.42 stud channels spanning 9 ft (2.7 m), assumed to be fixed-fixed as indicated by Applicants, have a predicted peak end rotation of 2.7 degrees, and peak ductility of 1.48. This is a Medium response for a non-load bearing component (LQT has confirmed that the roof loads shall not bear on the internal wall). Without considering composite action, which would be reasonable for the predicted Low plate response, this response level is considered acceptable.

SUMMARY

The results of the engineering evaluation indicate that response of the proposed aluminum wall system for over a 0.25 bar applied pressure over 600 msec, as originally sketched (internal studs spaced ever 24" (61 cm) o.c.) was determined to be unacceptable due to excessive deformation of the internal plates and stud channels.

By reducing the internal stud spacing to 12" (30 cm) o.c., the response of the system as a whole is considered acceptable.

In absence of published response values or test data for structural aluminum, the engineering evaluation has used engineering judgment to estimate reasonable response limits. It should be understood that these limits are not based on any specific blast resistant design code (such as API RP2-FP or ASCE).

Based on the low structural demand for most of the components, it is engineering evaluation finding that the basic design can be fine tuned to be rated for higher design loads, or some structural components can be resized for maximum cost economy, keeping the current load rating. Also, testing of a typical wall section may help to better understand the material response and determine more accurate response limits.

The following is a list of parts and materials suitable for use in the present invention:

PARTS LIST

<u>Parts Number</u>	<u>Description</u>
10	accommodations module

	12	interior living quarters
	14	exterior protective shell
	15	C-beams
	17, 19	side walls
5	20, 22	end walls
	23	aluminum sheets
	24	doorway
	26	ceiling portion
	28	floor portion
10	30	aluminum shell
	32, 34	side walls
	35	C-beams
	36, 38	end walls
	42	upper roof
15	50	insulation
	52	outer surface
	60	air space
	64	bolting connection
	66	upright anchor members
20	68	recesses
	72	base plate
	76	insulated cap
	80	corner support post
	82	inner support post
25	90	base plate
	94	L-brackets
	95	pad-eye
	97	body portion
	99	eyelet portion
30	100	arrows
	102	air duct
	110	beds
	120	blast
	125	air
35	126	vents

All measurements disclosed herein are at standard temperature and pressure, at sea level on Earth, unless indicated otherwise. All materials used or intended to be used in a human being are biocompatible, unless indicated otherwise.

5 The foregoing embodiments are presented by way of example only; the scope of the present invention is to be limited only by the following claims.

CLAIMS

1. An accommodations module, comprising:

a. an interior structure constructed of lightweight metal, such as aluminum, for housing workers;

5 b. an exterior structure constructed of lightweight metal, such as aluminum, for surrounding the entire interior structure;

c. a space provided between walls of the interior structure and walls of the exterior structure, so that there is no contact between the two structures;

10 d. an insulation material enveloping the interior structure and occupying some of the space between the two structures;

e. the insulation and space between the structures defining a means to reduce or eliminate the transfer of heat from a fire or force from a blast occurring outside of the exterior structure to be transferred into the interior structure.

2. The module in claim 1, wherein the insulation comprises 2" (5 cm) thick Firemaster Marine Blanket, Calcium Magnesium - Silicate Fiber Insulation with at least an A-60 fire rating.

20 3. The module in claim 1, wherein the module sizes range preferably from a 12' x 20' x 10'-6" (3.7 m x 6.0 m x 3.2 m), to 16' x 70' x 10'-6" (4.9 m x 21 m x 3.2 m).

4. The module in claim 1, wherein the walls are constructed as to not be connected, and allow the fire insulation blanketing to be a prime barrier to potential fire hazards.

5. The module in claim 1, wherein the walls constructed of aluminum do not corrode (oxidize) nearly as fast as steel in a salt laden marine environment.

30 6. A method of constructing an accommodations module, comprising the following steps:

a. constructing an interior structure of lightweight metal, such as aluminum, for housing workers therein;

35 b. constructing an exterior structure constructed of lightweight metal, such as aluminum of dimensions larger than the interior structure;

c. enveloping walls of the interior structure with an insulation material which resists heat and blast force;

d. placing the exterior structure over the interior structure so that there is defined a void between the insulated walls of the interior structure and walls of the exterior structure, with no direct contact between the two structures;

e. allowing the walls of the exterior structure to be impacted by heat from a fire outside of the exterior structure so that the void and the insulation between the structures define a means to reduce or eliminate the transfer of heat from the fire or to be transferred into the interior structure; or

f. allowing the walls of the exterior structure to be impacted by blast force from a explosion outside of the exterior structure so that the void and the insulation between the structures define a means to reduce or eliminate the transfer of force from the explosion to walls of the interior structure.

7. The method in claim 6, comprising the further step of allowing the insulation to melt from the fire and define a plastic fire proof coating on the outer wall of the interior structure.

8. The method in claim 6, further comprising the step of allowing air within the void between the structure walls to be vented from the void as the force of the explosion impacts the wall of the outer structure and forces it to move inward toward the wall of the interior structure.

9. The method in claim 6, wherein the step of making no contact between the walls of the two structures reduces or eliminates the possibility of heat transfer directly from the outer structure to the interior structure.

10. The method in claim 6, wherein the module, as constructed comprises the interior structure separate from the exterior structure, thus defining a building inside of a building.

11. The method in claim 6, wherein the external wall of light weight aluminum protects the fire wall blanket insulation material from the exterior environment and provides more structural safety for the building.

5 12. The method in claim 6, wherein the dual wall system provides more air space for increased insulation benefit for greater efficiency for heating and cooling the building.

13. An accommodations module, comprising:

10 a. an interior structure constructed substantially of lightweight aluminum, for housing workers;

b. an exterior structure constructed of lightweight aluminum, having dimensions greater than the dimensions of the interior structure;

15 c. a void defined between walls of the interior structure and walls of the exterior structure, when the exterior structure is placed over the interior structure, with no direct contact between the two structures;

20 d. an insulation material having at least an A-60 fire rating enveloping the interior structure and occupying some of the void between the two structures;

e. the insulation and void between the structures defining a means to reduce or eliminate the transfer of heat from a fire occurring outside of the exterior structure to be transferred into the interior structure.

25 14. An accommodations module, comprising:

a. an interior structure constructed substantially of lightweight aluminum, for housing workers;

30 b. an exterior structure constructed of lightweight aluminum, having dimensions greater than the dimensions of the interior structure;

c. a void defined between walls of the interior structure and walls of the exterior structure, when the exterior structure is placed over the interior structure, with no direct contact between the two structures;

d. an insulation material having at least an A-60 fire rating enveloping the interior structure and occupying some of the void between the two structures;

e. the insulation and void between the structures defining a means to reduce or eliminate force from damaging the interior structure from an explosion occurring outside of the exterior structure.

15. A method of fabricating an interior structure within an exterior structure so that an event such as a fire or explosion occurring on the outside of the exterior structure does not harm occupants in the interior structure, the method comprising the following steps:

a. fabricating the interior structure as a single enclosure of lightweight metal;

b. enveloping the interior structure with an insulation material of at least an A-60 fireproof rating;

c. fabricating an exterior structure larger than the interior structure of likewise a lightweight metal;

d. positioning the exterior structure over the interior structure so that there is defined a void between the interior structure and the exterior structure with no direct contact between the two structures; and

e. allowing the insulation and void space to serve as barriers between heat or force to impact the interior structure and harm occupants therein during a fire or explosion occurring outside of the exterior structure.

16. The method in claim 15, wherein the interior structure is fully insulated and covered by the outer structure, thereby protecting the structural integrity of the inner structure and providing stable support for an upper module that may be stacked and supported by the module from below.